







POPULAR MECHANICS DO-IT-YOURSELF ENCYCLOPEDIA

FOR
HOME OWNERS, PLUMBERS,
AND HUSBANDS
OF TWENTY VOLUMES



Volume 10

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POPULAR MECHANICS DO-IT-YOURSELF ENCYCLOPEDIA

FOR
HOME OWNER, CRAFTSMAN
AND HOBBYIST
IN TWELVE VOLUMES



Volume IX
POW TO SCR

Complete Index in Volume XII

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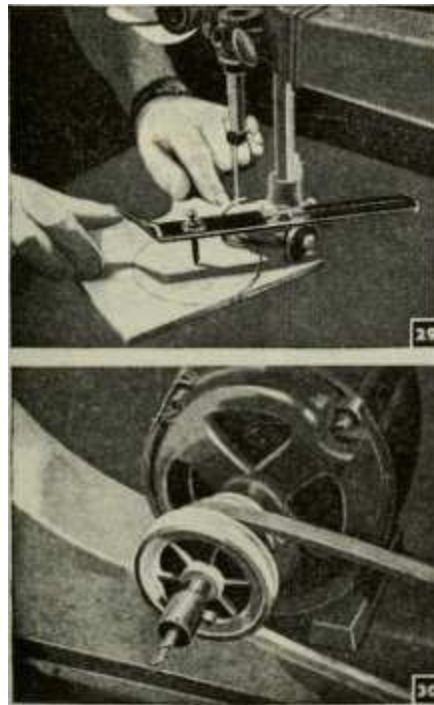
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NEW YORK

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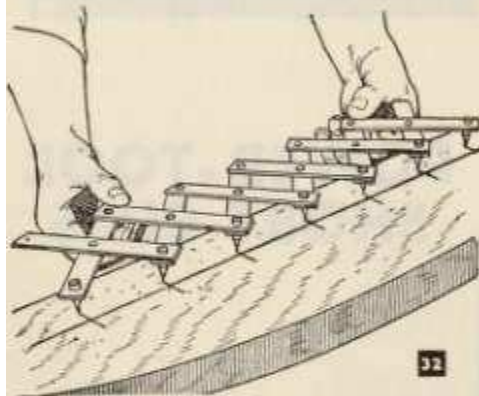
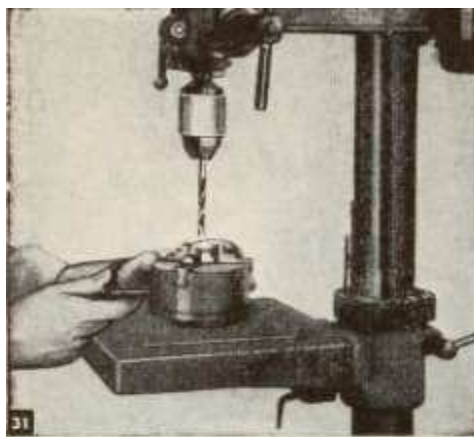


= POWER-TOOL SHORT CUTS

Jigsaw: The crosscut gauge for use on a jigsaw in Fig. 26, and the pivot fixture in Fig. 29 for cutting disks are two good examples. The gauge is one from a circular saw and is turned upside down and used on a jigsaw table as pictured. The pivot fixture is merely a length of flat iron having a point at one end and a slot at the other to straddle a machine screw on the blade-guide assembly. The slot also permits adjustment of the pivot to cut disks of various radii. A pointed stove bolt serves as the pivot. It is important that the pivot be at right angles to the blade teeth so that the latter will not draw to one side.

When cutting intricate scrolls in thin stock, the needle-pointed jigs shown in Fig. 27 will aid in maneuvering the work over a jigsaw table. When duplicating a design on several pieces of work, time can be saved by making a mimeograph stencil of the design, then

cementing it to the underside of a light wood frame and using it as a means of transferring the design out-



line to the work as indicated in Fig. 30.
Fig. 30 shows a fixture on a jigsaw motor for making starting holes when cutting inside designs. In this case, the fixture was made from a hole cutter by removing the cutter arm and then inserting the cutter-arm holder tightly in the cone pulley on the motor.

Drill press: Likely, few inexperienced operators realize the versatility of this machine when jigs and fixtures are used in connection with it. As an example, lack of a drill-press vise need not be a handicap if a lathe chuck is at hand. It makes a good substitute as shown in Fig. 31, and can be bolted to the table when used on special setups. As a timesaver when laying out equally spaced holes to be drilled, the jig shown in Fig. 32 is hard to beat. It is nothing more than a "lazy tong" having the pivot holes along one side enlarged to take short pencils. A drill press not having a tilting scale can be set accurately by using angle blocks as shown in Fig. 33.

The problem of cutting round tenons on irregularly shaped work is solved by using a hole cutter in a drill press as shown in Fig. 34. Shoulders are cut after the tenon has been formed. If you have experienced difficulty in holding small round work to drill the end, a cam-locking vise like the one shown in Fig. 35 will help. Pulling the handle causes the wood cam to wedge the work tightly against two blocks screwed to a base.

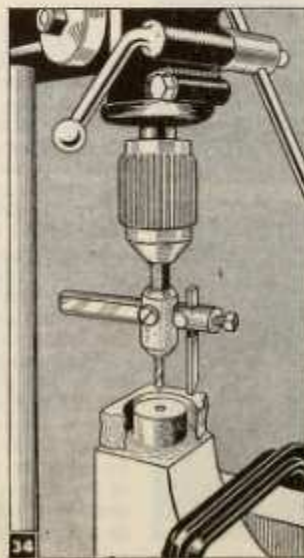


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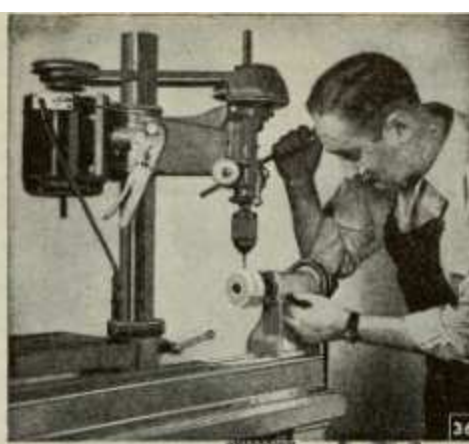
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In Fig. 36 the operator, lacking an indexing head for drilling, moved the drill press up to his lathe and used the indexing head on the latter. The jig pictured in Fig. 37 takes all the worry out of drilling holes in mitered frames for starting nails or screws. If you have a job that requires sanding the inner surfaces of rings it can be done quickly on a drill press using a strip of abrasive cloth held in a split dowel, Fig. 38. A wide strip cut from inner tube and snapped around the drill-press table. Fig. 39, provides a non-slip surface for flat work. A mandrel for a variety of cleaning and polishing operations is shown in Fig. 40. It consists of a wood cylinder wrapped with steel wool in the roll form. The cylinder is mounted on a steel arbor and is grooved lengthwise to hold one end of the steel-wool roll, which then is wound onto the cylinder in a direction opposite to that of rotation. No other fastening is required as the wool will quickly mat itself together in use. Always wear goggles when operating this poUsher.

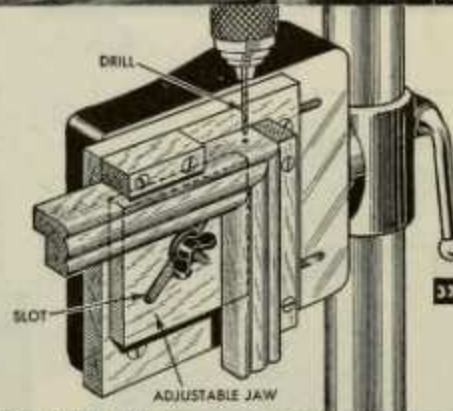
Bandsaws: Although handsaws usually are limited to sawing irregular outside shapes in wood and metal, there are several simple jigs and fixtures that can be made to increase the versatility of these saws. The jig for splitting a dowel. Fig. 41, is just one of many. It is merely a straightedge to which the dowel to be split is nailed at one end. In use, the straightedge is pushed along a fence. Such a jig is



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36



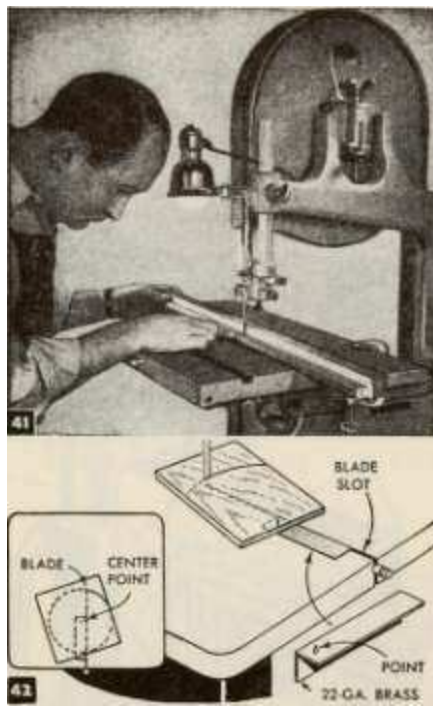
37



39



40

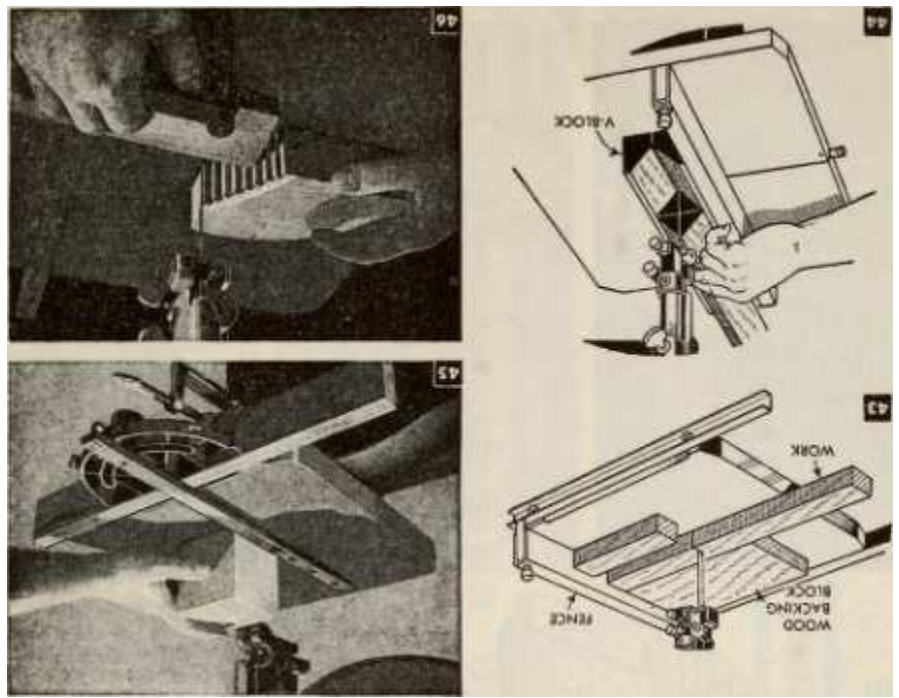
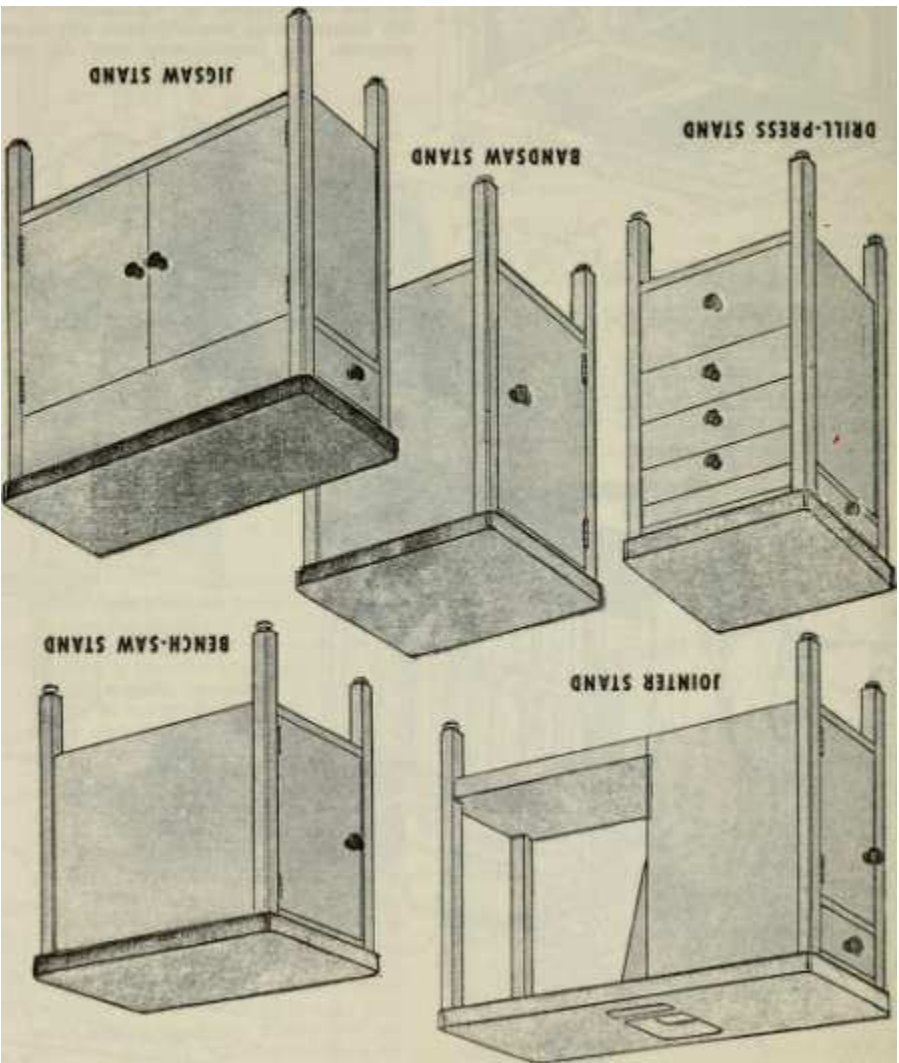


22-GA. BRASS

handy for flattening one side of long dowels, which later are cut into short lengths for making doveled-and-glued joints.

The pivot point shown in Fig. 42 simplifies the job of cutting true disks on a handsaw. The point is soldered near one end of a piece of brass, which is bent at right angles to slip into the blade slot in the table. A wedge holds the brass piece in place. For cutting duplicate pieces to length, a setup like the one shown in Fig. 43 makes a production machine of your handsaw. The backing block serves as a crosscut guide. If your handsaw is equipped with a ripping fence, it can be used to center turning squares quickly and accurately. Make a long V-block to slide along the fence and run the saw blade in from one end as shown in Fig. 44. Then place the work in the block and push the assembly against the blade just enough to score the work.

If a handsaw does not have a ripping fence, one can be improvised for some kinds of work by simply turning the crosscut gauge upside down and using it as shown in Fig. 45. A C-clamp will keep the gauge in position. The step gauge in Fig. 46 is handy when you have varied short lengths of work to cut off. It also is useful in cutting dowels to short lengths when using them in assembly work.



& basic frames

[-Back](#)

-Sides

11/4" open

Stock by first determining the required size of the openings and then cutting the stock accordingly. In making the top for the jointer stand, for example, you can cut a number of pieces 42 in. long and then join, use filler strips 17 in. long to form the openings for both chips and the drive belt.. Note in detail A the built-up construction of the tops. Either soft wood, such as pine, or hardwood, such as maple or birch, can be used for the tops. The motor shelf on the jointer and lathe stands can be made of the same material joined with glue and plywood splines as in detail A. When cutting stock for the motor shelves and tops, cut each piece slightly longer than the finish dimension to allow for trimming the top to the required size. Tops should be sanded smooth

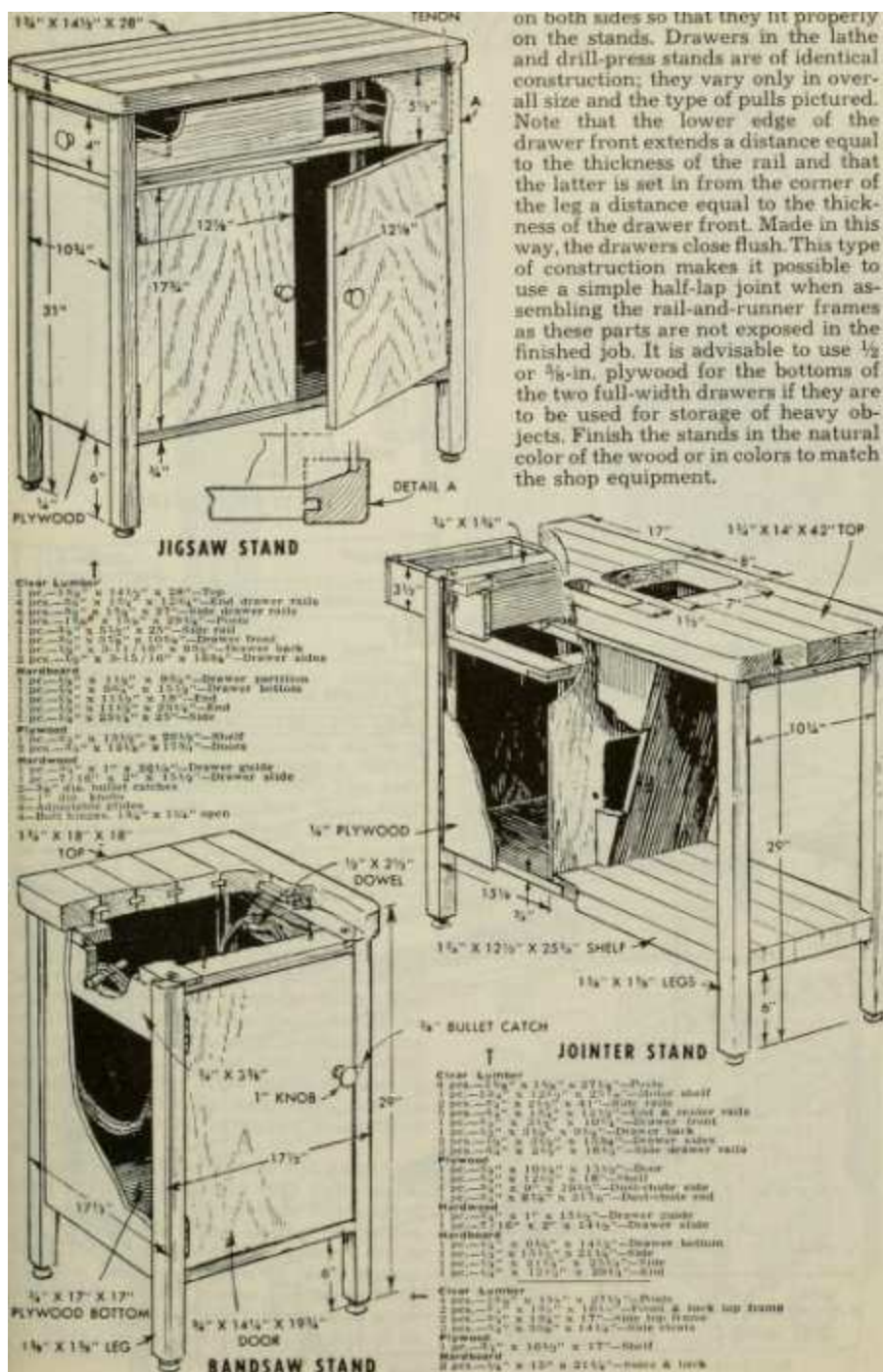
$$y_4''x_4y_4''x_7V_4'$$

DOOR

 $\gt T^\wedge$

BENCH-SAW STAND

$$1^{\wedge} "X \ 14 'A "X_{28}$$



on both sides so that they fit properly on the stands. Drawers in the lathe and drill-press stands are of identical construction; they vary only in overall size and the type of pulls pictured. Note that the lower edge of the drawer front extends a distance equal to the thickness of the rail and that the latter is set in from the corner of the leg a distance equal to the thickness of the drawer front. Made in this way, the drawers close flush. This type of construction makes it possible to use a simple half-lap joint when assembling the rail-and-runner frames as these parts are not exposed in the finished job. It is advisable to use 1/2 or 3/8-in. plywood for the bottoms of the two full-width drawers if they are to be used for storage of heavy objects. Finish the stands in the natural color of the wood or in colors to match the shop equipment.

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Clear Lum

1 PC—13/4

4 pes.— ^"d

4 pes.— 3/i" X 1 ^/4'

4 pes.—15** X 15

1 pe.—34" X 51/2"

1 pe.—3,,,: ' : ••-' ■•

1 pe.—l/i" :

2 pes.—1/2" Hard board

1 PC.—1/4" X 1 "2"

1 PC.—1/4" X 934" 1 PC—1/4" X 1 11/2" 1 PC—i/i" X 111/2" 1 pc.-l-i" X 231/4" Plywood

Hardwood

I Sl hack top frame

■X IH" LEG

Clear Lumber

1 PC—lli" X

2 pcs^— 3<," X

MATERIAL LIST

21/4"

4 pes. —3/4" X 13.4"

8 pes.— 3,;," X 1 3'4"

1 PC—3/4" X 21/2"

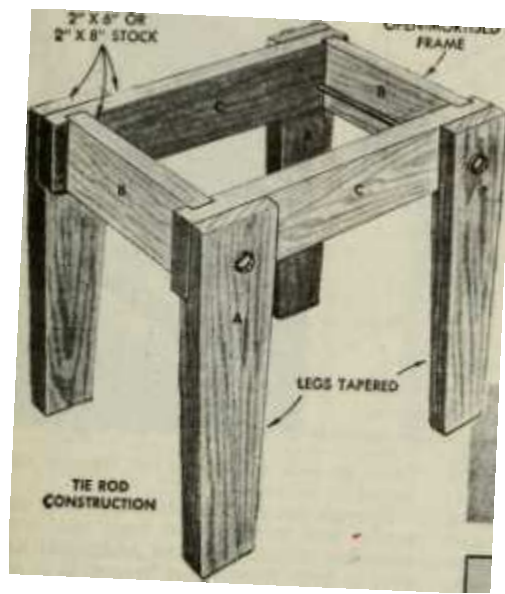
2 pes.—34" X 4" X 1 PC—14" X 71/2"

1 pe —1/2" X 1 1/2"

2 pes.—1/2" X 3" X

T PC—34" x"3V4' 4 pes.— 1 5/g" X !■ Hardwood





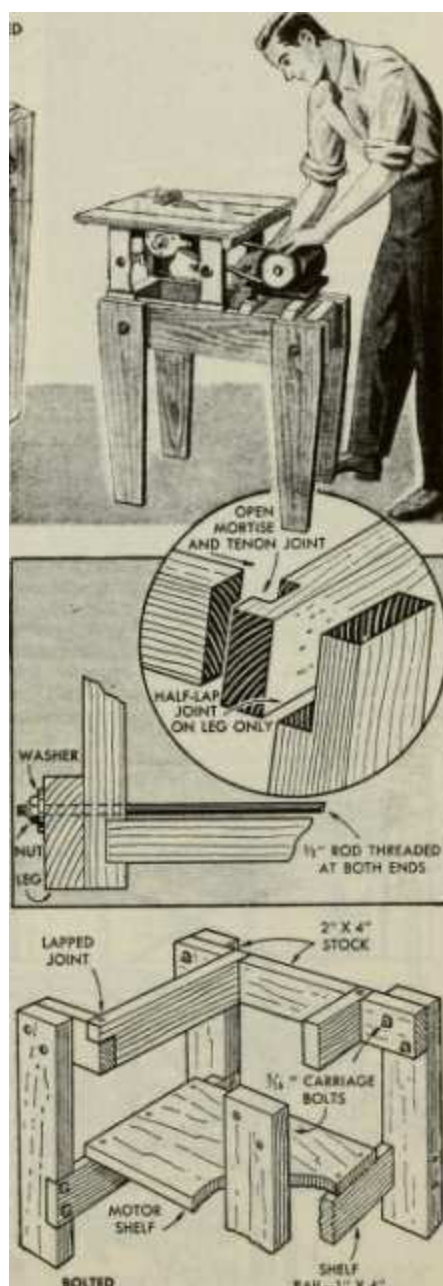
TIE ROD

CONSTRUCTION

MANUFACTURED steel or cast-iron stands are first choice for machine installation, but many crafters get along nicely with inexpensive stands made of wood. A favorite type employs tie-rod construction, as shown above. The only fastenings required are two V-shaped rods, threaded at each end. Wood used should be yellow pine, white oak, elm or similar wood hard enough to withstand strains without crushing. The method of housing all joints provides ample stiffness when the tie-rod nuts are drawn up tight.

Equally practical is bolted construction, as shown in the drawing at the right, using suitable lengths of carriage bolts. The width and length of the stand should be obtained directly from the machine being mounted. A top is not usually required since the various cross members can be arranged to provide mountings for the bolts necessary to fasten the machine in place.

The height of the stands will vary with different machines and may also be increased several inches over standard if you are tall. Average heights above the floor, including stand and machine, are as follows: Bandsaw table, 42 in.; circular-saw table, 39 in.; shaper, 34 in.; jointer, 32 in.; lathe (top of bed), 36 in.; disk sander, 36 in.; belt sander, 37 in.; jigsaw, 42 in. To determine the height of the stand



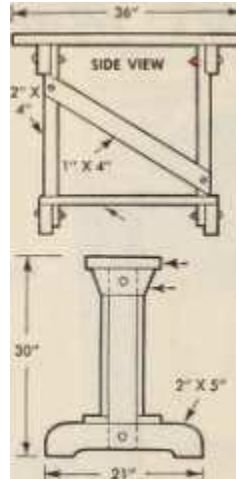
BOLTED CONSTRUCTION

itself, it is necessary to deduct the height of the machine from base to work surface from the dimensions listed.

A good style of stand for a wood lathe is shown in the drawing at the right. This should be made of maple or oak. Parts are assembled with glue, bolts and wood screws. The dimensions given are only general and may be altered to suit. Provision must be made for mounting the motor, either on a floating mount hinged to the back of the top or underneath the stand.

Rigid stands for power machines and frames for workbenches are easily and cheaply made of angle iron. Effective methods of construction and bracing are indicated in the drawing below. Most important to the rigidity of the stand is the manner of joining the corners, which is shown in an enlarged detail. It will be seen from this that 4-in. angle stock is used for the lengthwise piece, while 1-in. angle iron forms the leg and crosspiece.

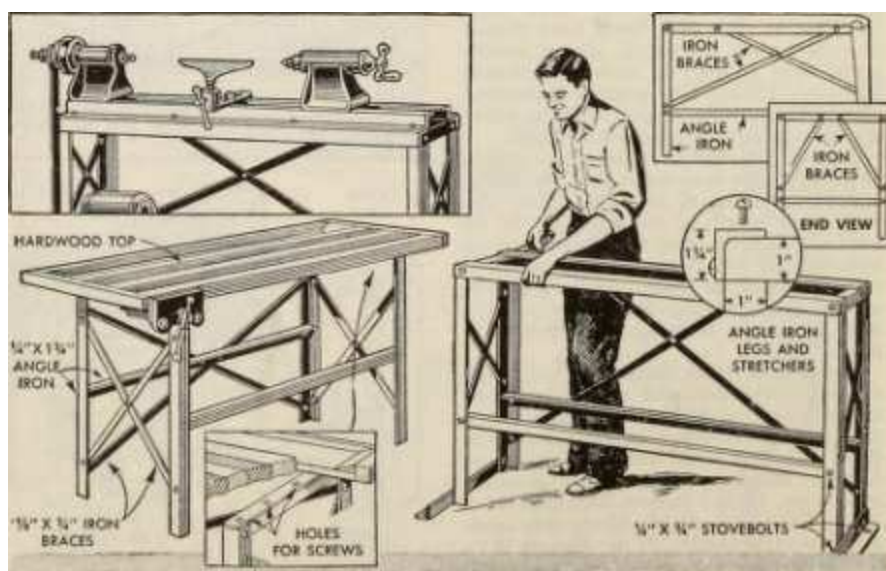
After cutting, the end of the crosspiece is filed to a rounding contour so that it fits the rounded corner of the 4-in. stock neatly. Holes are drilled for $\frac{1}{2}$ -in. stove bolts, and the nuts are drawn



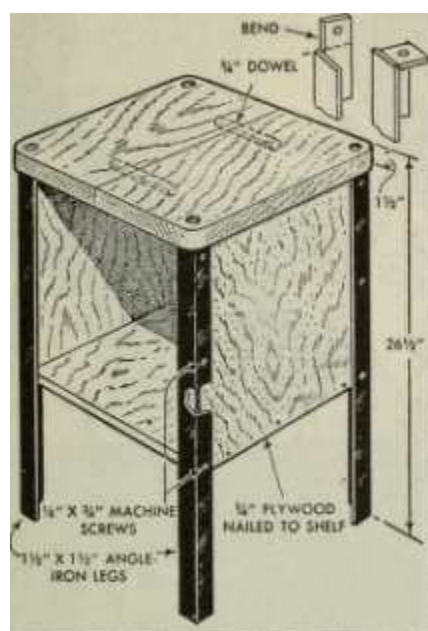
down on lock washers if the stand is subjected to vibration.

Though not always necessary, it is generally best to put in at least one lower stretcher which will give additional support to both frames and braces. It is also a good idea to fit narrow machine stands with feet, as shown at the right, to prevent any tendency to tip.

If welding equipment is available, use it for angle-iron assemblies. The welded joint is neater and stronger than bolts.



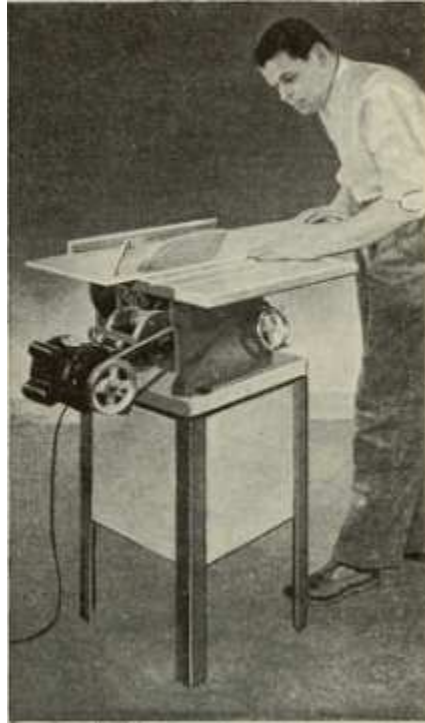
1/8" X 1/4" IRON BRACES



Angle-iron power-tool stands of bolted construction are usually the most feasible in a small shop, however, and they are almost as sturdy as those which are welded. If you want to economize, here are two sturdy stands that cost little and are simple to build. The one detailed above is particularly suitable for a tilting-arbor saw, the open front providing a handy shelf on which to place the miter gauge or the fence whenever one or the other is not being used. However, if the stand is made to support a tilting-table saw, a belt slot can be cut in the top for driving the machine from below. The legs are lengths of angle iron which are bolted to a thick wooden top and made exceptionally rigid by plywood panels on three sides. Note how the upper ends of the angle iron are drilled, cut and bent for attaching.

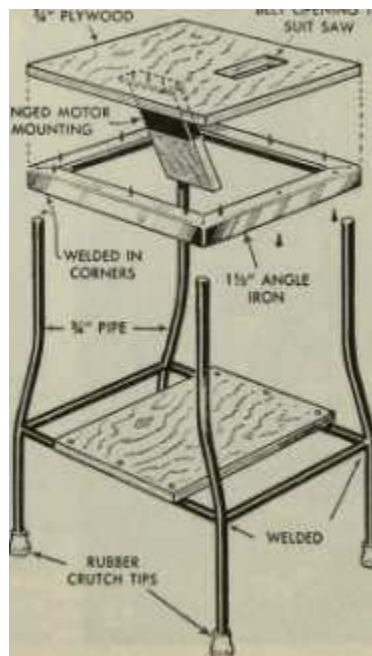
The legs and lower framework of the stand at the right consist of 1/2-in. pipe, the legs being flared at the bottom for added stability and welded at the top to an angle-iron framework covered with plywood. This particular stand is made to order for a tilting-table saw with a hinged motor mount being employed. A lower shelf provides a place to lay accessories,

and rubber crutch tips fitted over the ends of the legs reduce vibration. The angle-iron frame supporting the plywood top is formed from one piece, a V-cut being made at three corners to permit making 90-deg. bends.



BELT OPENING TO SUIT SAW

HINGED MOTOR MOUNTING '





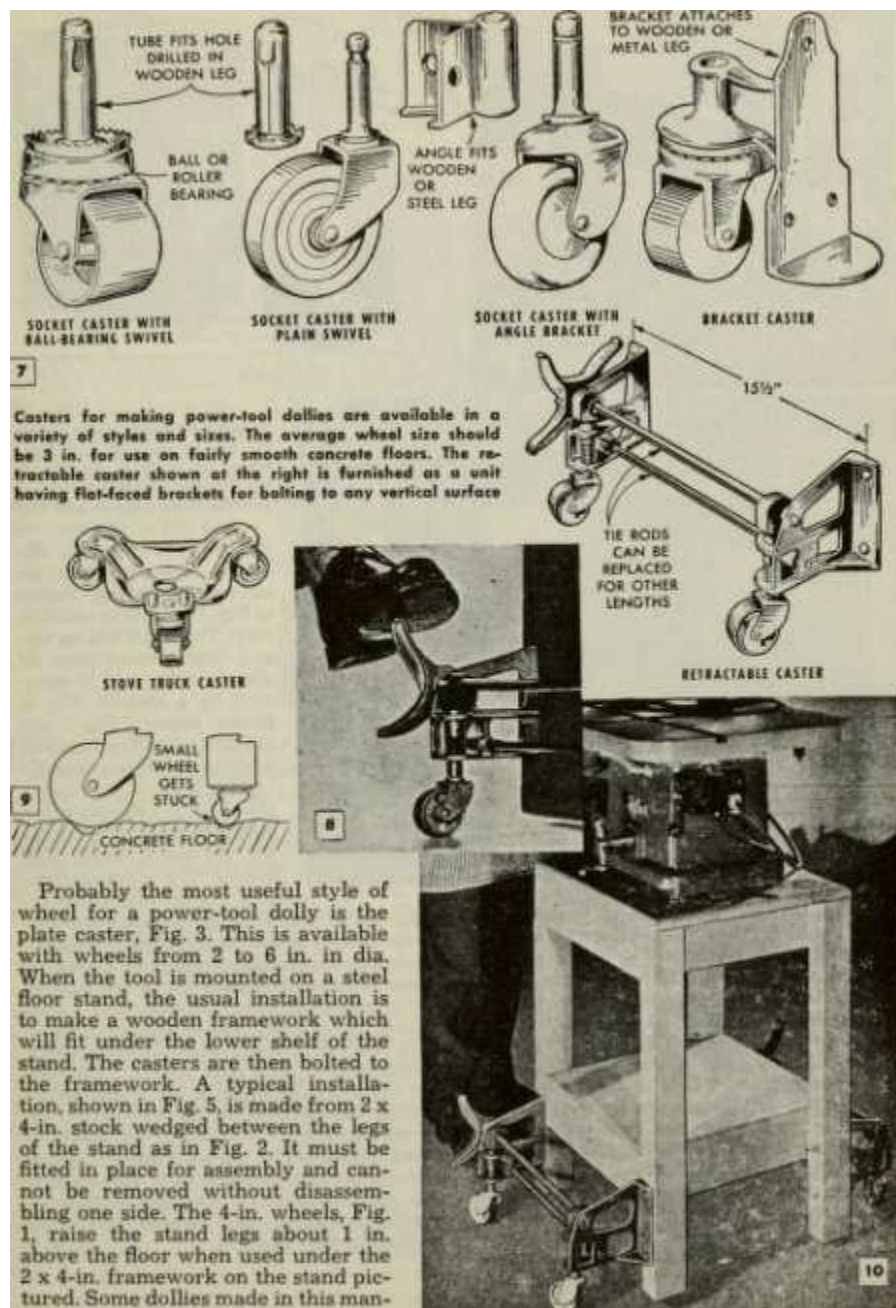
POWER-TOOLS ON WHEELS

FEW HOME SHOPS are big enough to provide ample work area for several power tools. When the space is limited, such machines as the bandsaw, shaper and circular saw must be moved to accommodate long stock. At best this is a difficult job and may result in damage to the machine and also the shop floor. A dolly fitted with three or four swiveling casters enables the operator to move the machine to the required position with a minimum of time and effort. Caster wheels of the types shown should be at least 2 in. in dia. and, better, 2½ or 3 in. If your shop floor is concrete and rough in spots, nothing less than 3 or 3½-in. wheels should be used in order to permit easy rolling, Fig. 9. The best wheel for a concrete floor is a steel wheel having a rubber or laminated-leather tire, such as is used in the installation shown in Fig. 5. Plain steel wheels are a good second choice although they are noisy on rough concrete. Plastic and composition wheels are satisfactory only if the floor is fairly smooth.

POWER-TOOLS ON WHEELS

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BRACKET ATTACHES TO WOODEN OR METAL LEG

SOCKET CASTER WITH BALL-BEARING SWIVEL

SOCKET CASTER WITH PLAIN SWIVEL

B

Casters for making power-tool dollies are available in a variety of styles and sizes. The average wheel size should be 3 in. for use on fairly smooth concrete floors. The retractable caster shown at the right is furnished as a unit having flat-faced brackets for bolting to any vertical surface



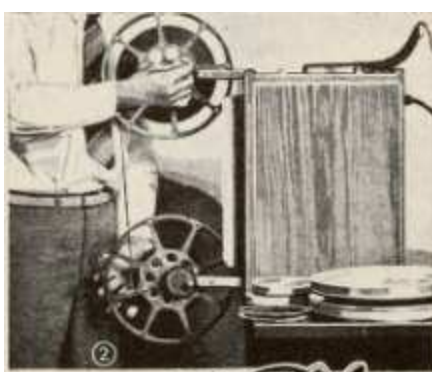
STOVE TRUCK CASTER

Probably the most useful style of wheel for a power-tool dolly is the plate caster, Fig. 3. This is available with wheels from 2 to 6 in. in dia. When the tool is mounted on a steel floor stand, the usual installation is to make a wooden framework which will fit under the lower shelf of the stand. The casters are then bolted to the framework. A typical installation, shown in Fig. 5, is made from 2 x 4-in. stock wedged between the legs of the stand as in Fig. 2. It must be fitted in place for assembly and cannot be removed without disassembling one side. The 4-in. wheels, Fig. 1, raise the stand legs about 1 in. above the floor when used under the 2 X 4-in. framework on the stand pictured. Some dollies made in this manner may require blocking to raise the stand or half-lapping of the frame to lower the stand to get the desired lift of $\frac{1}{2}$ or 1 in. above the floor.

Although the retractable-caster units are best to use on a bench which permits attaching them inside the legs, they can be mounted on the outside of the legs as shown above

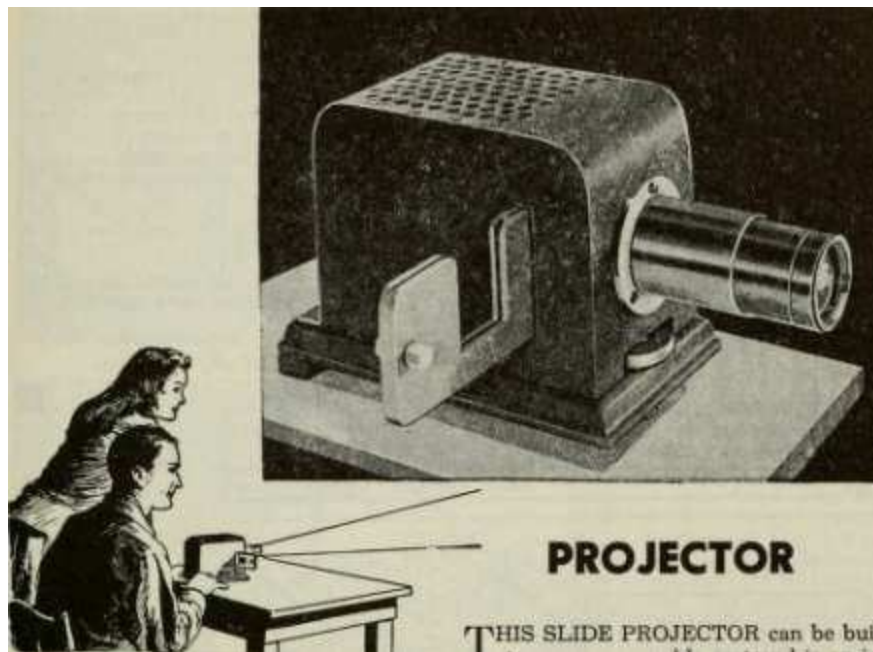
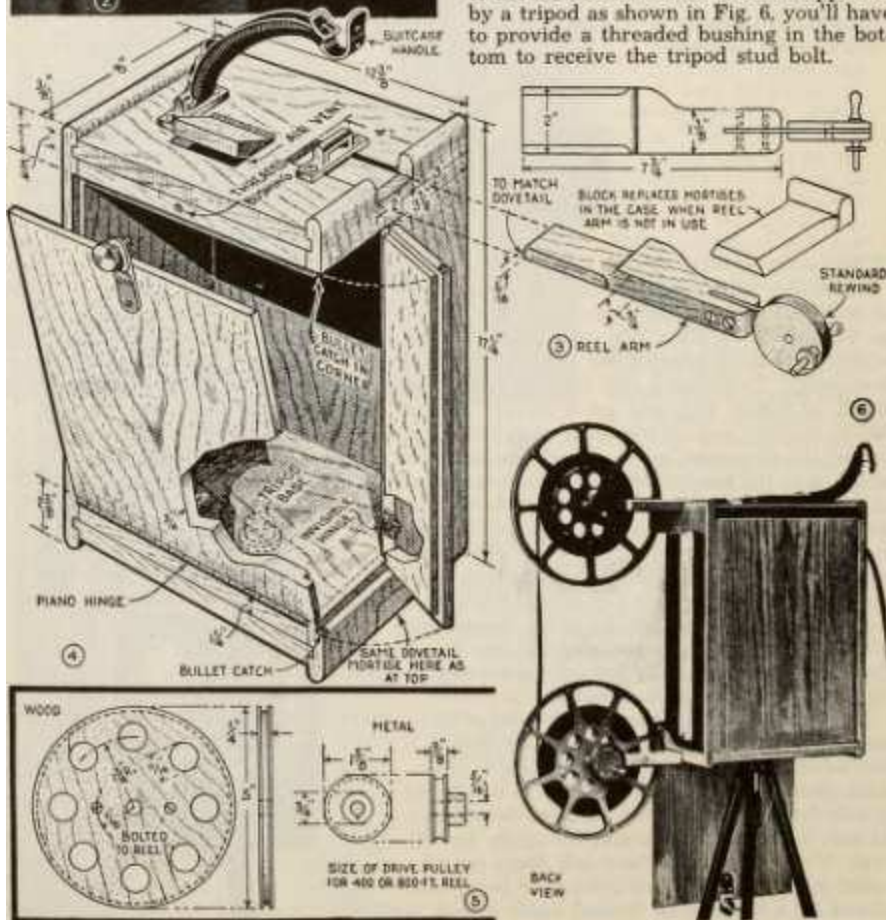
top and bottom corners. The side door is hinged to a strip which is set flush and screwed to the bottom. At the top, a similar strip is added to receive the door rabbet and the threaded bushing for a thumbscrew. A small hasp or lock could be used

in place of the arrangement shown. The back of the case also is rabbeted, which makes it necessary to assemble the sides, top, bottom and back at the same time. Filler blocks to replace the extension arms when they are not used, are cut to fit the dovetail mortises rather snugly so they will not fall out. Their purpose is merely to give a finished appearance to the case by concealing the mortises. These blocks and the arms are detailed in Fig. 3, while Fig. 5 gives the size of the two pulleys. If you are unable to obtain a suitcase handle like the one shown, that is, with buckles at each end to permit detaching it from the case, a wooden handle may be substituted. In making the wooden handle, be sure to allow ample clearance for opening the vent door. The projector can be operated with the side door closed without overheating. Lining the case with felt or cloth adds a finish to the inside. If the case is to be supported by a tripod as shown in Fig. 6, you'll have to provide a threaded bushing in the bottom to receive the tripod stud bolt.



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THIS PIECE IS

Inner SHELL

SHEET-METAL PARTS ARE SAWED ON BANDSAW

PROJECTOR

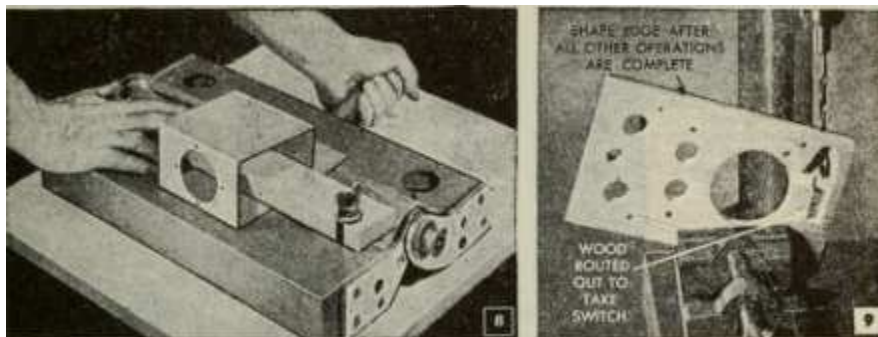
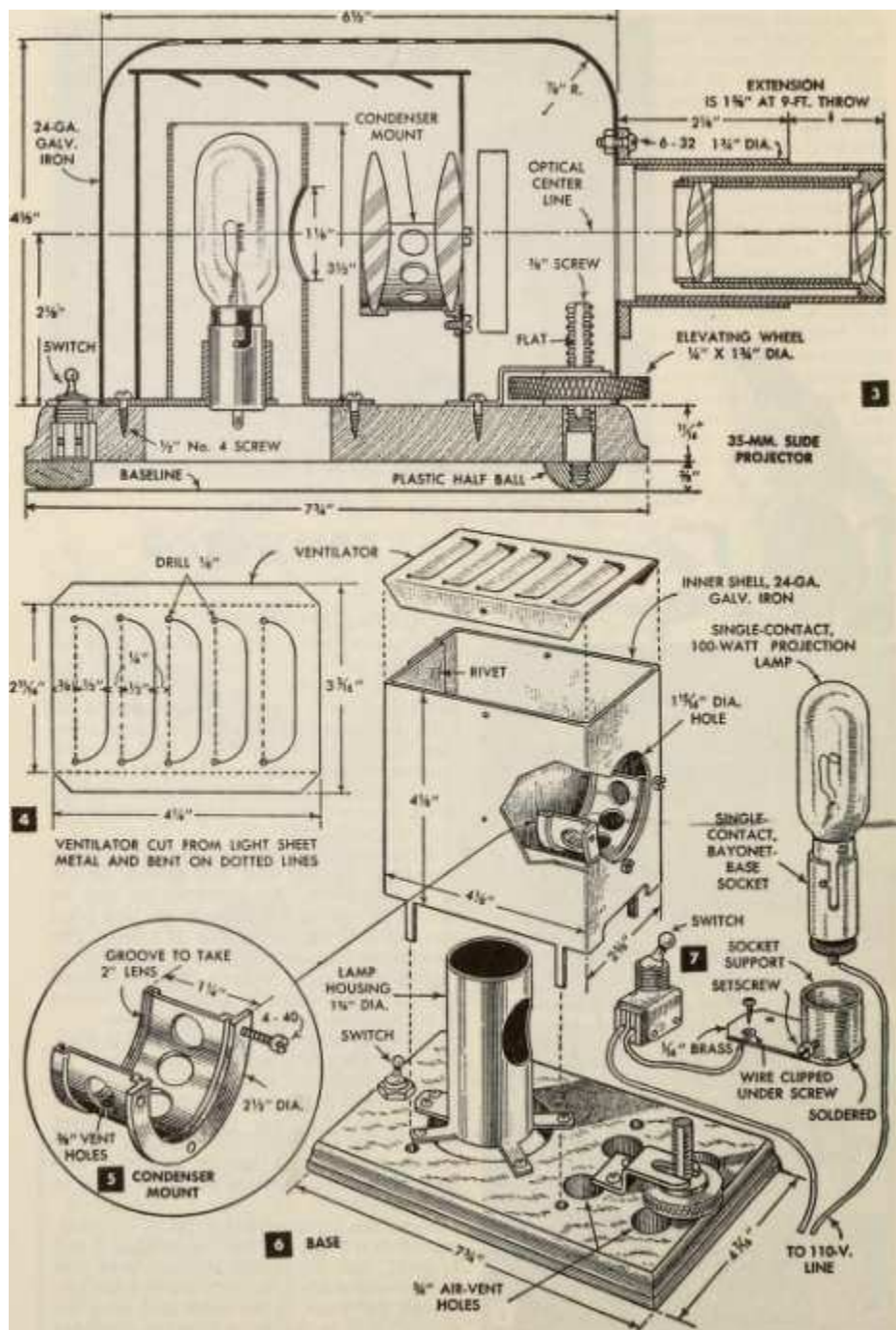
THIS SLIDE PROJECTOR can be built at a very reasonable cost and is an interesting job for the home craftsman. The unit takes a 2 by 2-in. cardboard ready-mount, which is the common mounting for both purchased slides and the transparencies you shoot with your own camera. Lenses suggested are stock items and can be obtained from optical supply dealers. Tests have shown that performance of the unit is excellent.

A full-size detail of the lens mounting is shown in Fig. 12, and this should be the first item made. Its construction can be varied to suit—a lot depends on just what you can pick up in the way of tubing. The lens mounting screws inside a piece of tubing which is a slide fit inside a second tube, and the latter is attached by means of a threaded ring to the outer case.

The condenser mount is detailed in Figs. 3 and 5. This is a split turning, made by turning down the part in the full round and then sawing in half about 1/8 in. beyond the center. Grooves for the condenser lenses must be measured carefully as the lenses should snap lightly in place, and once seated they should be fairly loose in the grooves.

Make the lamp-socket support by turning down a piece of brass to fit, Figs. 3 and 7. Next, cut the brass support arm and then sweat-solder the two parts together. Chuck the work in the lathe and bore the support arm to the same internal diameter as the socket support. Drill and tap for a

EXTENSION IS 1H" AT 9-FT. THROW



BENDING THE INNER SHELL WITH BENDING BRAKE

46" No. 19 NAILS 4" PLYWOOD

4 SCREWS HOLD OUTER CASE TO BASE



DRILLING HOLE IN BASE FOR WIRE

setscrew to hold the lamp socket in position.

The outer case, or housing, consists of $\frac{1}{2}$ -in.-plywood sides covered with galvanized sheet metal, Figs. 1, 2 and 3. If you like metalwork-ing make an all-metal case. The wooden sides simplify the construction somewhat and are quite practical as they are well protected from lamp heat by the housing and inside shell. Tack the plywood sides together and saw out both parts in one operation, including the opening for the slide changer. Mount the lens on the case, and then make the slide changer, Figs. 10 and 11. Note that openings into the slots are rounded over before gluing so that the slides can be inserted easily. Wipe excess glue out of the slideways.

The base. Figs. 3 and 6. is wood. Note that one end of the lamp housing is split four ways to form lugs for attaching to the base. The inner shell. Figs. 3 and 6, is 24-gauge galvanized sheet metal Since the inner shell carries the condenser mount and the combination ventilator and light trap. Fig. 4, it should be made accurately to stand square; cut it to size on the handsaw. Fig. 2. Opening for the condens-

OPTICAL SYSTEM

... SHOULD BE MADE UP OF OPTICS SHOWN, OR CLOSE SUBSTITUTES. CONDENSER SYSTEM IS CHECKED AS SHOWN IN PHOTO. DETAIL BELOW SHOWS HOW DOUBLE-CONTACT SOCKET CAN BE CHANGED FOR SINGLE-CONTACT LAMP

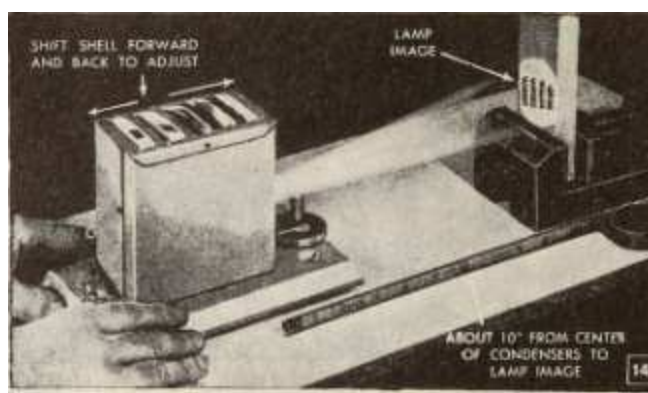
DOUBLE CONTACT SOCKET

BRASS DISK

m

LAMP

100-WAH, SINGLE-CONTACTa PROJECTION LAMP

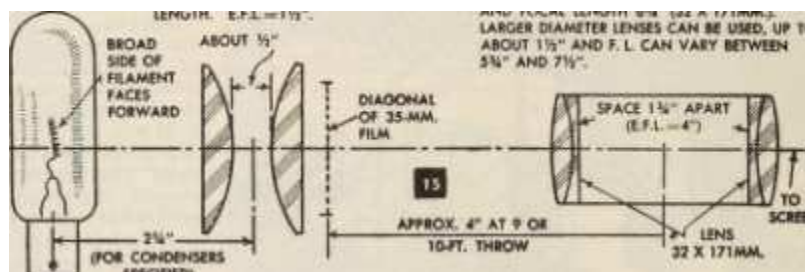


CONDENSERS

PLANO-CONVEX OR CROSSED CONVEX. 2" DIA. BY 3" FOCAL LENGTH. E.F.L. = 14 1/2".

PROJECTION LENS

USE TWO ACHROMATS OR SINGLE PLANOCONVEX LENSES. DIAMETER SHOULD BE 1 1/2" AND FOCAL LENGTH 6" (32 X 171AAM.). LARGER DIAMETER LENSES CAN BE USED, UP TO ABOUT 1 3/4" AND F. L. CAN VARY BETWEEN 5 1/2" AND 7 1/2".



SCKON

(FOR CONDENSERS SPECIFIED)

LENS 32X171AUM.

ers is cut on a jigsaw or with a holesaw. It is important that the 2 1/8-in. dimension from the top of the base to the optical center line be maintained in making all parts, Fig. 3. Fig. 8 shows the inside shell being bent on a sheet-metal brake, but of course this can be done in a vise, using wooden blocks to bend the corners square. Fig. 9 shows the base being drilled for wiring. Note that the bottom is routed out to take the toggle switch, Figs. 6 and 7.

The light unit for the projector is a 100-watt projection lamp of the single-contact type, and is fitted into a corresponding single-contact bayonet-base socket. Fig. 15. You can use a double-contact lamp and double-contact socket. However, the single-contact lamp is a standard item, but the single-contact socket is not standard. You can alter a double-contact socket, as in Fig. 13, by soldering a disk of brass over the contacts. Then use the double post as a single post and take the second wire from the screw holding the socket

support, as in Fig. 7.

At this stage the unit should be tested. Make the setup in Fig. 14 and move the partly assembled projector forward and backward until the image of the lamp filament is sharply focused. Note that the

distance from the center of the condensers to the image should be about 10 in. Some adjustment is possible by moving the inside shell forward or backward. The 10-in. distance is specific for the lenses shown. If you use a larger-diameter lens, pick up the lamp image about 15 in. from the center of the condensers.

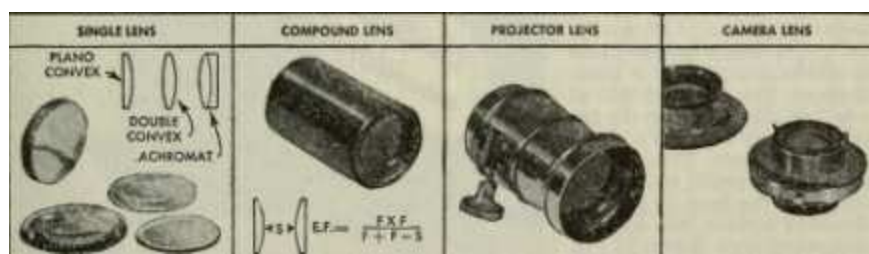
While the optical elements specified are standard, there are certain substitutions. Condensers must be at least 2 in. in diameter in order to cover the diagonal of the slide. Focal length of the condensers should be about 3 in.; two of these very nearly in contact have an equivalent focal length of one half the individual lenses. For the projector lens, two 32 by 171-mm. achromats are suggested. Spaced 1 in. apart, the equivalent focal length will be about 4 in., which is the right figure for average home use where the throw from the projector to the screen is 8 to 10 ft. Shorter focal-length lenses will give a larger image with a shorter throw while a longer focal length results in a smaller image and a longer throw.

The finish on the projector must withstand heat. Use a baking enamel, black inside and any color outside. Bake at low heat in the oven with the door open.

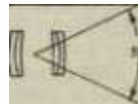


PROJECTOR

A PROJECTOR is an optical \blacksquare^* - device for enlarging opaque copy and projecting it on a wall, screen or sheet of white paper. Artists, sign writers and many craftsmen find a projector very useful. To use it, fasten the drawing, picture or clipping to a copy board, place the board in the projector box, snap the switch and there's your pictui-e—any size you want it with only shght adjust-



PIANO-
CONVEX LENSES



HEAVY PINCUSHION DISTORTION-ABOUT 1/2" IN 12" AT IMAGE



VERY SLIGHT DISTORTION-NOT OVER 1/16" IN 12" AT IMAGE

SLIGHT DISTORTION ABOUT 1/32" IN 12" AT IMAGE

FAIR ILLUMINATION. WORKS BEST AT $f/16$ TO

$f/16$

GOOD ILLUMINATION. WORKS AT $f/8$ TO

EXCELLENT ILLUMINATION. WORKS AT $f/4$ TO

GOOD TO EXCELLENT. WORKS AT $f/4$ TO $f/8$

POOREST TYPE OF LENS AND SHOULD BE USED ONLY FOR JUVENILE PLAY PROJECTORS. SINGLE ACHROMATIC LENSES ARE NO BETTER THAN PLANO OR DOUBLE CONVEX

BEST INEXPENSIVE TYPE. ONLY FAULT IS NARROW FIELD. SHOULD BE ABOUT 8" EQUIVALENT FOCAL LENGTH (E.F.). COST OF LENSES 1 ¢, DIAMETER ABOUT 20¢ EACH

©

BEST TYPE FOR LONG THROWS OR WHERE STRONG ILLUMINATION IS NEEDED.

COST IN RACK-AND-PINION MOUNT ABOUT \$15. FOCAL LENGTH SHOULD NOT BE SHORTER THAN 6Vj"

BEST ALL-PURPOSE LENS. RAPID RECTILINEAR TYPE RECOMMENDED IN VIEW OF LOW COST (ABOUT \$3). OTHER TYPES (ANASTIG-MATS) ARE TOO EXPENSIVE FOR GENERAL USE

ments of the copy board and lens. With minor changes in design a projector works equally v.'ell when used in the horizontal position, Figs. 1 and 3, for projecting pictures on the wall -ir a screen, or in the vertical position. Fig. 4, where it is used for projecting images onto an easel or drawing board so they can be traced in outline or in full detail.

General lens terms: The lens is the heart of the projector. Before discussing lenses, a few general temns should be understood; first of all, the focal length. If you hold any lens in sunlight and over a piece of paper, you will find that at a certain distance from the paper, the lens projects a sharp image of the sun. The distance from lens to paper is the focal length of the lens. If you are checking a thick lens like the compound type shown in Fig. 2, the focal length should be measui-ed from paper to about halfway between the two lenses. This is not exactly accurate, but is close enough for practical use. Lenses recommended for projectors run about 4V2 to 10-in. focal length. The f: value of any lens indicates the ratio between the focal length and lens diameter, and is found by dividing the focal length by the diameter. For example, a lens of 12-in. focal length and 1-in. diameter is rated f :12. If you take a piece of cardboard with a V2-in. hole in it and place it over the same lens, the f: value then is 12 divided by Vz or f :24. It can be seen that the higher the f: number the less light the lens will pass. Such lenses are called "slow." Lenses recommended for projectors should have an f: value of 11 or faster because good illumination is important.

Lenses: Lenses are described graphically in Fig. 2_From a study of this table, you



1. GENERAL DIMENSIONS OF BOX-es determined by distance from lens to copy and size of copy covered.
2. WORKING SPACE NEEDED-as determined by distance from lens to image.
3. THE SIZE OF COPY any lens will cover at any specified degree of enlargement.

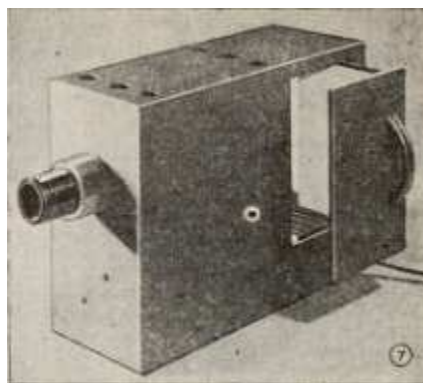
will note that the compound lens is the best lens for an inexpensive projector. Camera lenses are best if you want a large field, but the cost of a modern camera lens of suitable focal length is too high to make it practical for projector use. An earlier type of camera lens, the rapid rectilinear, or R. R., makes an excellent projector lens and usually can be

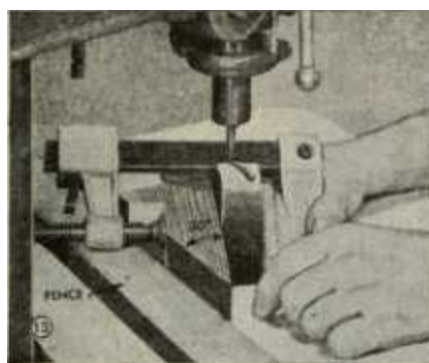
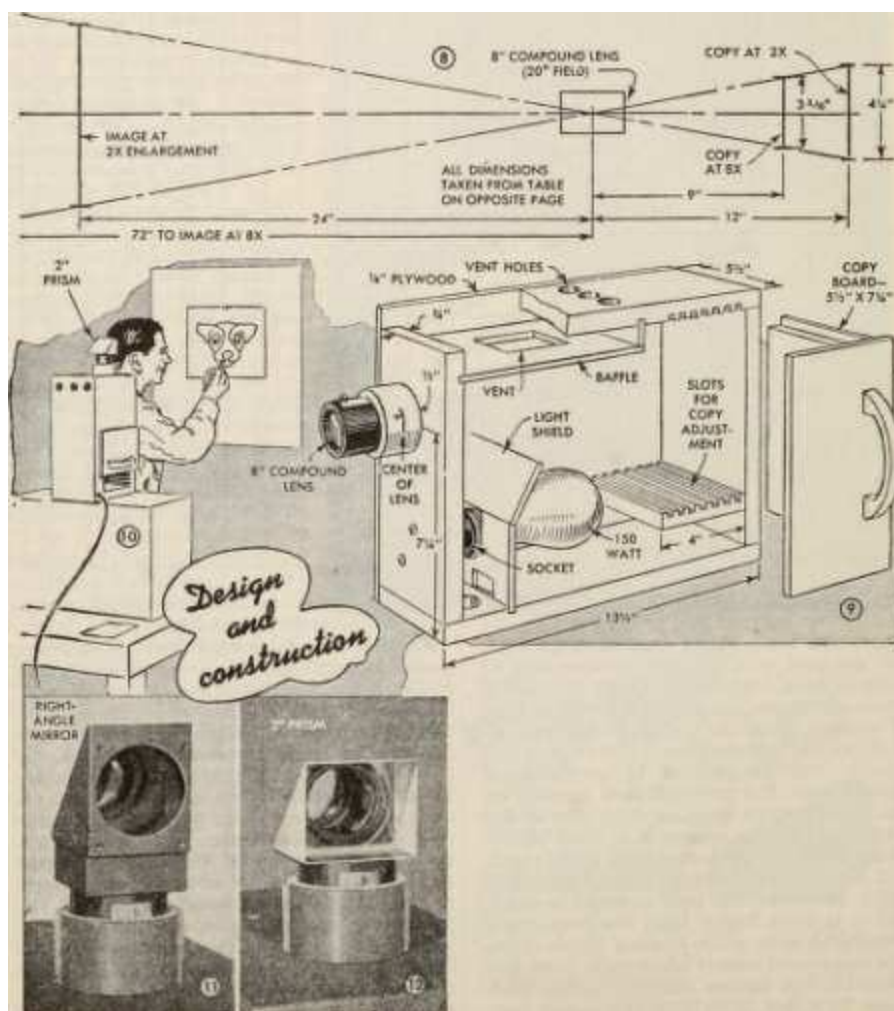
located in second-hand photo stores. The projector lens is really an old-type portrait lens; in fact, one of the very first camera lenses. It is used extensively on movie projectors and gives excellent illumination because it can be worked at $f:4$. However, the field covered is small, and it is little better than the homemade compound lens, while costing much more. The compound lens is homemade from two plano-convex lenses which you can purchase for a few cents from any dealer handling chipped-edge lenses. It gives good definition over a 20-degree field when stopped down to about $f:8$.

Making the compound lens: The compound lens in a slide-type mount is detailed in Fig. 5. Cylinders can be plastic or wood. The lenses should be about 1 1/4-in. diameter by 1/5-in. focal length. The calculation for figuring the equivalent focal length of the combined lenses is given in Figs. 2 and 5. In this specific example, it works out at about 8 in. In order to favor the narrow field, the focal length should not be shorter than 7 in. Any lens of this type will give the best definition, or sharpness of image, if it is stopped down to about $f:8$ or $f:11$. To find the size of stop for any focal-length lens, divide the focal length by the desired f : number. In the example shown, Fig. 5, the focal length is 8 in., so the stop diameter would be 1 in. for a value of $f:8$.

Lens table: The lens table. Fig. 6, gives

all the data you need in designing a projector for any particular lens or for any particular purpose. You will note that a long focal-length lens coupled with high magnification means a long throw from projector to screen, while a short focal-length lens means a short system. Also note that, for any specific lens, the longer the focal length the wider the field or size of copy you can cover. You will find that lens selection is a matter of compromise. You probably will want a fairly short system, possible with a short-focus lens, but at the same time you will want the large field obtained with a long-focus lens. If you use a single, compound or projector lens, you will have to go to at least 7 or 8-in. focal length

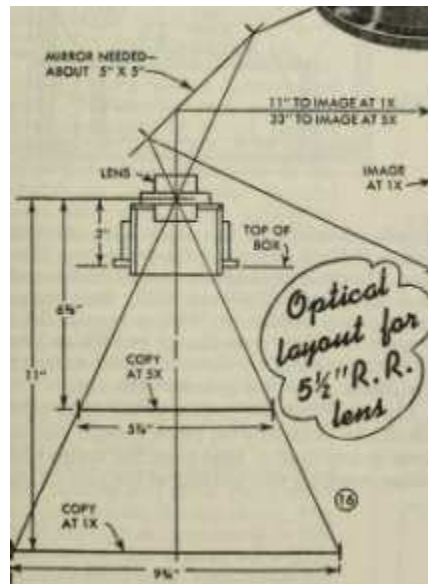




Erecting the image: A projector made as in Fig. 9 reverses the copy. This is not important for cutout work, but if you are working with lettering an erect image is needed. Erecting the image can be accomplished with a right-angle mirror, Fig. 11, or a 2-in. prism, Fig. 12. Both of these items can be purchased for about one dollar each from dealers handling surplus optical goods. When used with a mirror or prism, the box is mounted with the lens pointing toward the ceiling, as shown in Fig. 10.

distance from lens to image will be 72 in. The total length of the system would be 84 in. when working at 8X. Obviously, a system this long could not be worked vertically because the average room height would not accommodate it. However, it would make a satisfactory horizontal projector. Made up as such, the construction might be something like Figs. 7 and 9, although the box can be any of a dozen shapes as long as it incorporates the optical distances needed.

MIRROR NEEDED ABOUT 5"X5'

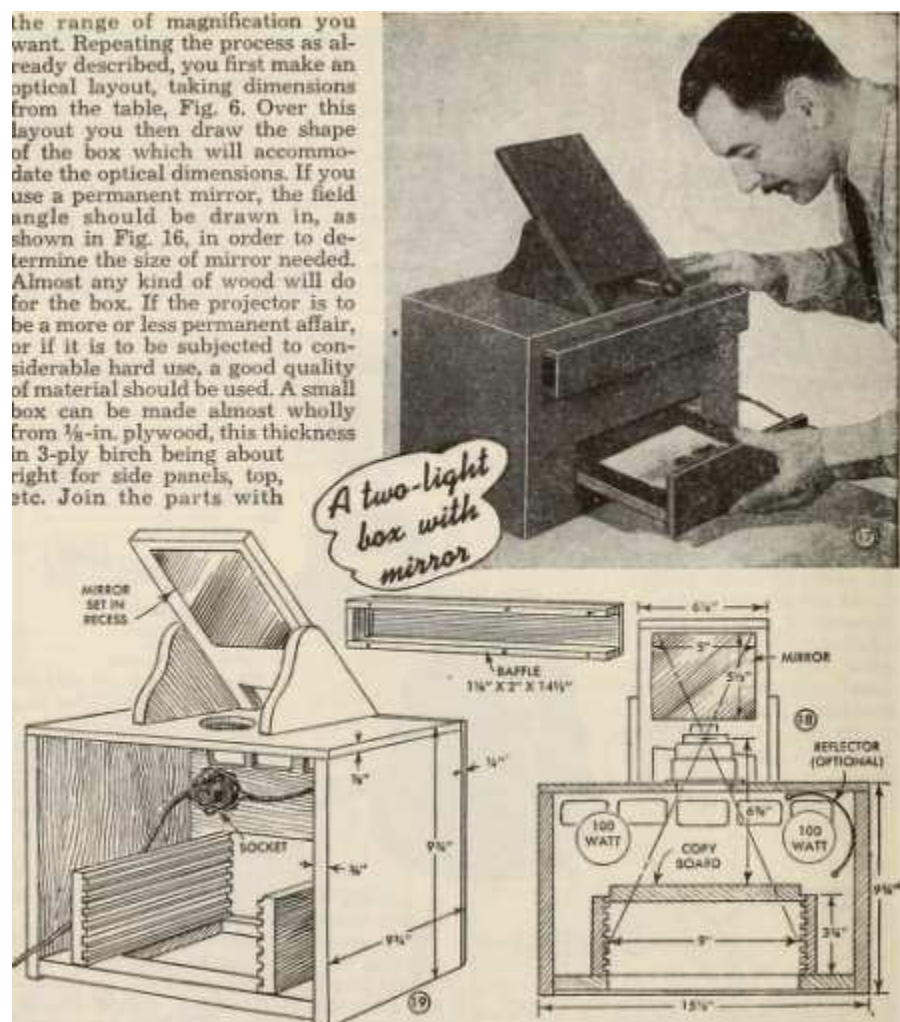


The mirror or prism then will direct the image horizontally.

Spiral focusing mount: A good type of mount for the compound lens or for an camera lens is the spiral focusing mount shown in Figs. 14 and 15. Cylinders can be of wood or plastic. Fig. 13 shows how the slot is routed in a drill press.

The erecting projector: The mirror for erecting the image can be mounted permanently as part of the projector. In designing a system of this kind, optical dimensions are taken from Fig. 6 as previously described. A typical layout showing a 5Vain, rapid rectilinear lens in a spiral focusing mount is shown in Fig. 16. The R. R. lens covers a field of about 50 degrees. At 5X the lens shown will cover copy 5% in. square. Figs. 17, 18 and 19 show how the construction is worked out to accommodate the optical dimensions. Built as shown, the box is designed primarily for horizontal mounting, as indicated in Fig. 1, but it also can be mounted vertically, as shown in Fig. 4. However, if specifically for vertical projection, it would be better to have the copy slide in from the end of the box.

Building your own: Specific projector designs serve only to show the general construction. When you design your own, you must make the box to suit your lens and the range of magnification you want. Repeating the process as already described, you first make an optical layout, taking dimensions from the table. Fig. 6. Over this layout you then draw the shape of the box which will accommodate the optical dimensions. If you use a permanent mirror, the field angle should be drawn in, as shown in Fig. 16, in order to determine the size of mirror needed. Almost any kind of wood will do for the box. If the projector is to be a more or less permanent affair, or if it is to be subjected to considerable hard use, a good quality of material should be used. A small box can be made almost wholly from $\frac{1}{4}$ -in. plywood, this thickness in 3-ply birch being about right for side panels, top etc. Join the parts with



small screws. There's no need to use glue in the joints. Where the copy board is tongued to slide in grooves, the grooves should be somewhat wider than the thickness of the tongue so that the board will slide in and out without sticking. The manner of making the light traps and baffles shown in Figs. 9 and 19 should be followed quite closely.

Limitations: Some limitations are worth noting: Lenses of less than 4-in. focal length should not be used because they require placing copy too close to the lens. Also, if anything but a camera lens, the field covered by a lens of less than 4-in. focal length will be too small. Lenses over 10-in. focal

length should not be used because this places the image too far from the lens. The magnification limit of the simple compound lens is about 8X—over that, the image lacks sharp definition. With a camera lens or projector lens you can go as high as you like, but you will need strong lights to carry the image over the greater distance.

Finish: Paint the inside of the lens tube black. An ordinary oil paint should not be used in any case as heat from the lamps will cause cracking and peeling of the paint film.

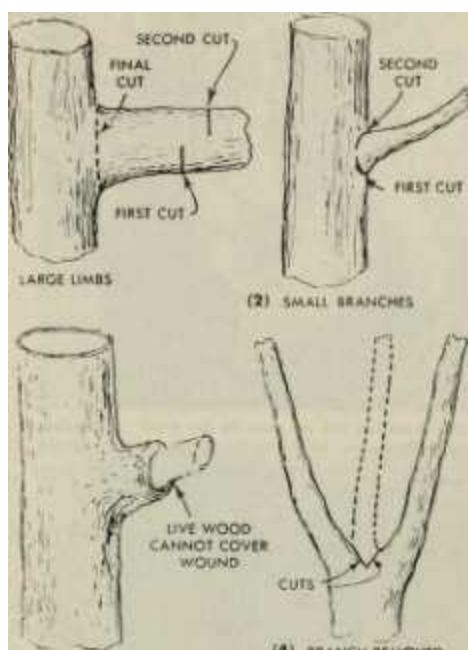
PRUNING

Pruning trees or shrubs is more than merely cutting off a few limbs or twigs here and there. Knowing what to take out and what to leave is the important thing, and this requires a careful study of each individual plant, taking into account its age, species and location. The time to prune varies with the locality. Some trees and shrubs can be pruned at almost any season while others will suffer extensive damage unless you do the job at precisely the right time. Experienced gardeners and orchardists say, that dormant pruning is done best during January, February and March, but that the later it can be done during the dormant season the better, as the wounds will heal more quickly.

Except for formal treatment, the natural shape of the tree should be given every consideration. Each type has a typical form and pruning should emphasize this. The elm, for example, generally has a loose-growing vase shape; the Norway maple has a dense oval and almost formal one, and the pin oak has a pyramid shape with horizontal branching. Any tree will attempt to regain its normal form, regardless of trimming done to change it.

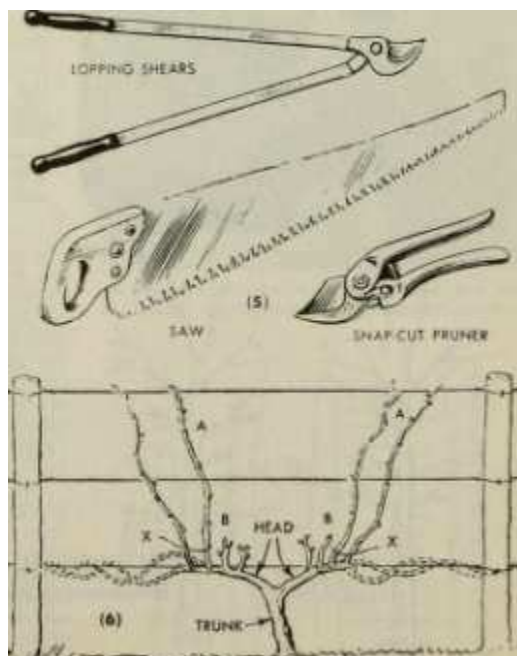
Most shade trees require relatively little pruning. Removal of dead, interfering and injured branches usually is all that is needed. All cuts should be made with a sharp saw as close to the crotch as possible and parallel with the adjoining trunk or branch. Leaving even a short stub will make proper healing of the cut difficult or impossible and may result in decay. Fig. 3 illustrates an incorrect cut where a stub has been left. Note that the live wood has been unable to cover the end and has receded, leaving a projection of dead wood which is ideal for decay. On smaller branches, the first cut should be made part way up from the bottom and then the second cut made from the top down. Fig. 2. If the cuts are not made in this manner, a tear that is very difficult to heal may result. Larger branches should be given even

(1) LARGE LIMBS



(3) WRONG WAY

(4) BRANCH REMOVED TO DEVELOP STRONG CROTCH



-1,1



Saw branches off as close to the trunk as possible (above), and scrape away any jagged edges (below)



SIDE

BRANCHES CUT CLOSE TO TRUNK

WRONG

more care. A safe policy to follow is the one shown in Fig. 1. The first and second cuts are made as indicated to drop the limb, and the final cut, which is made from the bottom and the top, is to remove the stub. Very small branches are trimmed with a snap-cut pruner, Fig. 5. Any jagged edges should be shaved off and the wound painted thoroughly with tree paint. Painting seals the cut and prevents moisture and decay from setting in before live wood covers the wound. Larger cuts should be painted each year because the cut portion may have a tendency to dry and crack. Some of the lower and inner branches of a tree usually die each year due to lack of sunshine. Also, some trees have a tendency to produce more branches than the roots can support and the weaker ones die off. These dead and dying branches should be removed regularly.

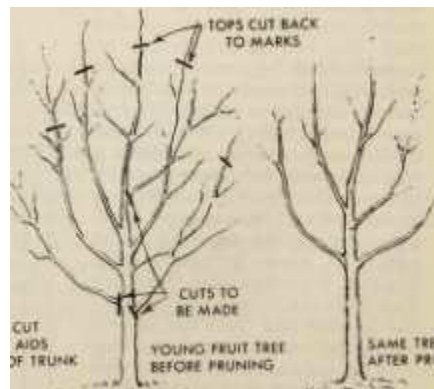
Frequently a tree will be found to possess a number of interfering branches which endanger the health of others by causing a crowded condition. Parallel branches too close together fall in this class also. Keep parallel branches at least a foot apart, and in removing interfering branches, study the over-all arrangement to maintain good balance. Worn spots caused by rubbing branches are likely to develop decay which may, in time,

spread to other portions. Rubbing is due frequently to crowded or parallel branches that are too close together. One should be removed to allow more freedom. Another point of interference is at a crotch. Fig. 4 illustrates a poor crotch caused by three branches coming out at the same point, forming sharp angles. Removal of the middle branch allows room for the others to spread without crowding. When a branch is torn off by wind, ice or snow, a jagged wound often results. Such an area should be cleaned until

(TOPS CUT BACK TO MARKS

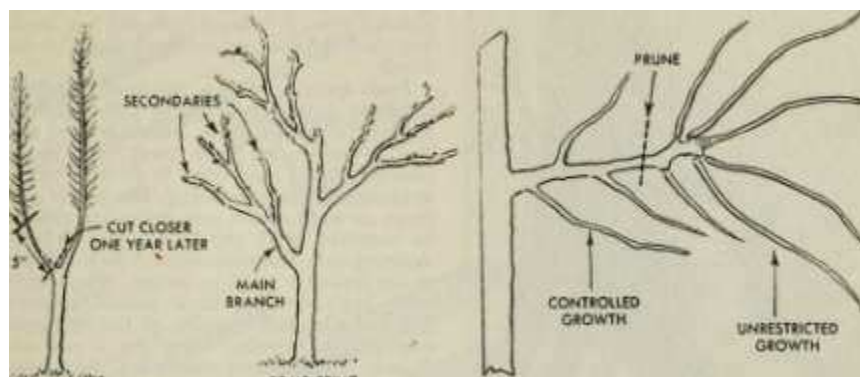
SIDE BRANCHES CUT BACK THIS WAY AIDS DEVELOPMENT OF TRUNK

RIGHT



SAME TREE AFTER PRUNING

CUT



REMOVE ONE LEADER

COMPLETING THE FRAME

UNRESTRICTED GROWTH

only firm wood is left and then painted. This may require lengthening the gash considerably, but that is better than leaving rough, frayed portions that will collect moisture. Paint for several consecutive seasons until the wound heals.

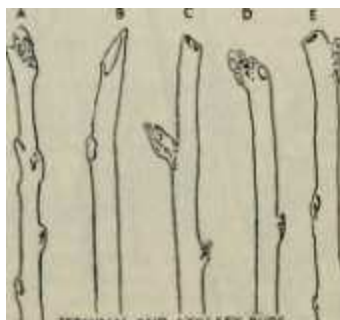
It's important to prune young trees because faulty branching can be corrected while the limbs are small. A good main crotch arrangement can be trained either high or low, depending on the tree's location. Street trees should be high so they will not interfere with traffic. Most lawn trees in city and suburban areas also should be "headed up" to permit circulation of air through the yard and to allow sunshine on the lawn. Where space is not at a premium, low trees add to the appearance of the yard. When training young trees, the side branches are sometimes completely removed up to the desired height, which makes the trunk weak.

When pruning, the location of the cut in relation to the buds is important. Detail A in the diagram on this page shows an un-pruned branch. The terminal bud is at the tip with cluster buds at the base; farther down are axillary buds, which may be found in pairs. In detail B the cut is long and slanting, causing the wound to dry too slowly. Detail C shows a cut too far ahead of the bud and the stub may rot. The cut is too close to the bud in detail D and it may dry and drop off. The correct way is shown in detail E where the cut has a slight slant and is about 1/4 in. above the bud.

If young trees have been planted, during the third year, or the second year if two-year trees were planted, treat each main branch as though it were an individual tree, except that the buds on it are not spaced around the branch, but should lie fanwise and parallel with the ground. This cutting forces the weaker buds below the cut to



The pruning wound should be painted thoroughly with tree paint, which seals the cut against moisture



TERMINAL AND AXILLARY BUDS



Small branches may be trimmed with a hand pruner (above), or with a pole pruner as below. A pruning pole can be equipped with a pulley and rope as indicated below to greatly increase the leverage. A pulley is attached to the cutting-head arm. The rope is passed through the pulley and fastened to a screw mounted on the pole about a foot or so from the top

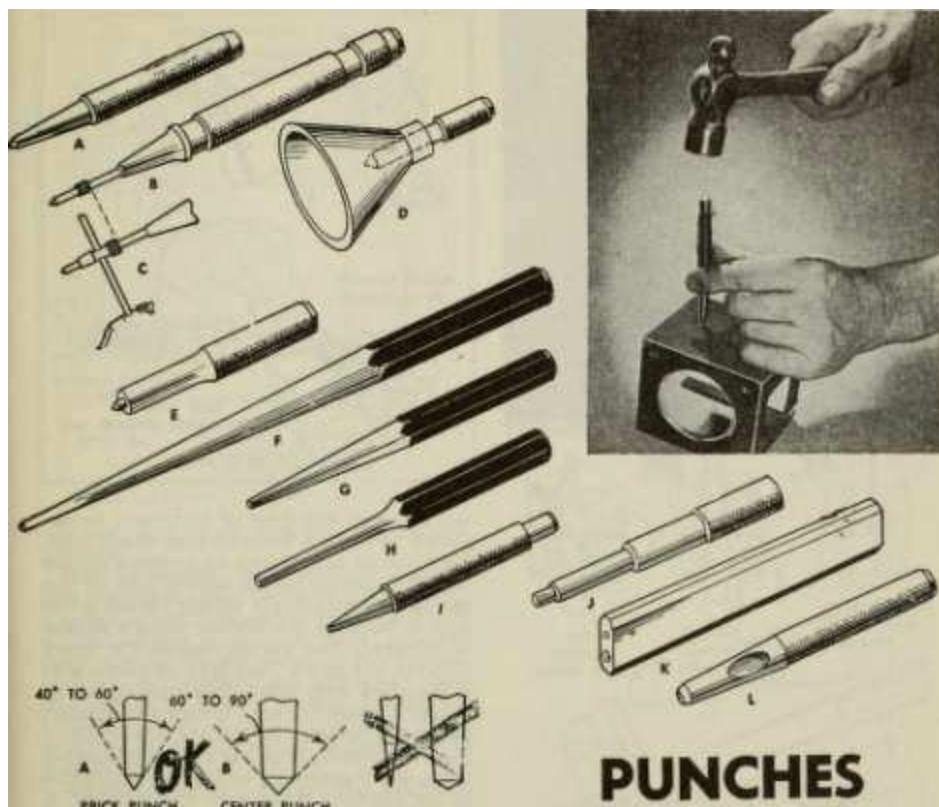


grow and form a well-knit frame. A newly planted tree, if it has developed two leaders, should have one cut back close to the trunk.

Fruit trees require a treatment slightly different from shade trees, although the method of pruning and the tools used are the same. Young fruit trees just being planted should be pruned to develop proper crotching and branching. The leader and three or four of the side branches should be retained. Both the leader and the remaining side branches should be cut back so the leader is 4 to 6 in. longer. When fruit trees begin to bear, their annual

growth generally lessens because of the strength required to develop fruit. As a rule-of-thumb, the need for pruning is limited usually to the removal of dead, interfering, diseased or damaged branches. There is one type of branch found on fruit trees that is not often encountered elsewhere. Sometimes this is called a "sucker" or "water" branch and will not bear fruit, but due to its rapid growth it will have a tendency to sap the strength from other branches. Most of these spring from the main branches and grow in an upright position. This type of growth should be removed as soon as it develops.

Grape vines: Among the several systems used for pruning grape vines, the one illustrated in Fig. 6 is widely chosen because it is simple and produces renewal canes that are close to the head. During the latter part of each winter, but not when the vines are frozen, leave two or more long canes, AA, having five to ten buds each, and cut a similar number of canes, BB, back to spurs having one or two buds each. Then cut away all other growth. In effect, the long canes will produce shoots on which grow the following summer's crop, while the short canes become renewals that will bear the crop of the second summer. Early in spring, bring the long canes down and tie them as indicated by the dotted lines. Later reduce each short cane to a single strong shoot and tie to the upper supports. This process is repeated each season. When selecting renewals always select those as close to the head as possible. In many cases these may be coming f^'om the trunk. The total number of buds that the long canes will carry depends upon the soil, vigor of the plant and similar factors. When well established, the popular Concord grapes can carry 50 to 60 buds to a vine, whereas less vigorous varieties should be held to a maximum of 25 to 30 buds to obtain the best yield. Like trimming trees, this type of work requires only a few simple tools. Lopping shears and a snap-cut pruner are all that are required to do the job in most cases.



40° TO 60°

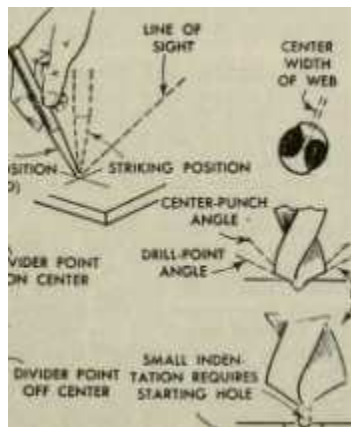
CENTER PUNCH

PUNCHES

LOCATING POSITION (INCLINED)



I



DIVIDER POINT ON CENTER

~ SMALL INDEN-

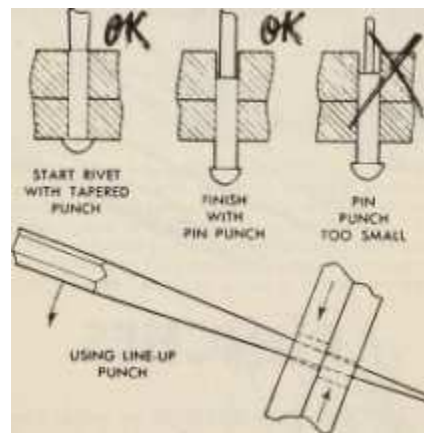
DIVIDER POINT TATION REQUIRES , OFF CENTER STARTING HOLE ^

BLUNTED PUNCH

ACCURATE LAYOUTS on metal begin ^^ with precise punch marks made on the surface. The accuracy of the indentations determines to a certain extent the accuracy of the work, especially when starting drills and laying off with scribes and dividers from a center line or base line. That's why die makers, machinists and others who regularly use center punches and prick punches in layout work take special care to prevent damage to the needle-sharp points. Various types of punches in common use are shown above, in details A to L inclusive. Details A, B, C, D and E show sharp-pointed punches. The others, F to L inclusive, classify as punches but are used for various types of work.

Center punches: The details at the right, A to D inclusive, show methods of using sharp-pointed punches in layout work and in making indentations in metal for starting drills. One trick in setting the point of the punch accurately is shown in detail C. The punch is

inclined so that the point is seen readily, and after locating the point, the punch is returned to the vertical position



USING LINE-UP PUNCH

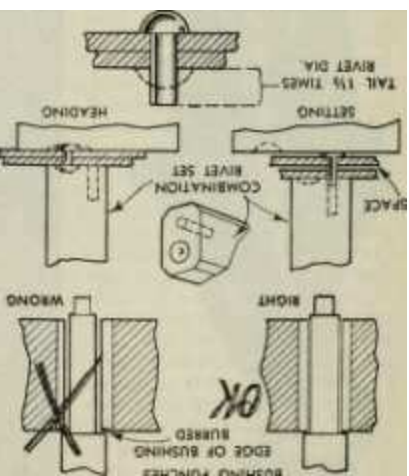
before striking with the hammer. In hole layout, the holes are located with light prick-punch marks and if large holes are to be drilled, starting holes or pilot holes are first drilled to assure concentricity. Indentations in the metal to anchor one leg of dividers should be made with a needle-sharp punch, as otherwise the dividers may shift. Sharp-pointed punches should always be ground concentrically so that the point will be located exactly on the axis. A simple grinding jig made as in the right-hand detail above will do the trick. A similar jig is pictui-ed in use in the photo at the left. The punch is guided by a V-grooved block of hardwood and grinding depth is limited by a hardwood collar attached to the barrel, or body, of the punc'h by means of a setscrew. Octagon punches can be concentrically ground by slipping the body of the punch into a short length of tubing. In ^he upper details on the preceding page, de-

tail B shows one type of automatic center punch which is a favorite with machinists. No hammer is required as pressure on the movable sleeve, which serves also as the handle, compresses a spring. When pressure is built up to a certain point a striker is released. The striker delivers a sharp blow on the point. This type of punch also is supplied with adjustable spacing arms, detail C, which are used to locate and punch centers equidistantly along a scribed line. The bell punch, detail D on the preceding page, is self centering and is made especially for marking centers on round stock. A similar type, detail E, is supplied in a range of shank sizes and is designed for laying out registering holes on matching pieces of stock.

Pin, machine and lineup punches: Pin punches are used for driving out pins, rivets and keys. They come in a wide range of sizes and have straight round shanks and flat faces. Machine and lineup punches are similar except that the shanks are tapered. The shanks of Lineup punches are much longer than either the pin or machine punches. In starting a rivet or pin, first use the machine punch to start, or "break" the rivet. Then finish driving it out with a pin punch. The reason for this procedure is that the tapered shank of the machine punch has much greater strength than the straight shank of the pin punch. In

driving out pins and rivets, select a pin punch having a shank diameter only slightly smaller than the rivet or pin, as otherwise the shank may be broken. Linup punches are used to align parts which are to be bolted together as in machine assembly. The long tapering shank will enter holes which are out of register and by moving the punch sideways the

BUSHING PUNCHES



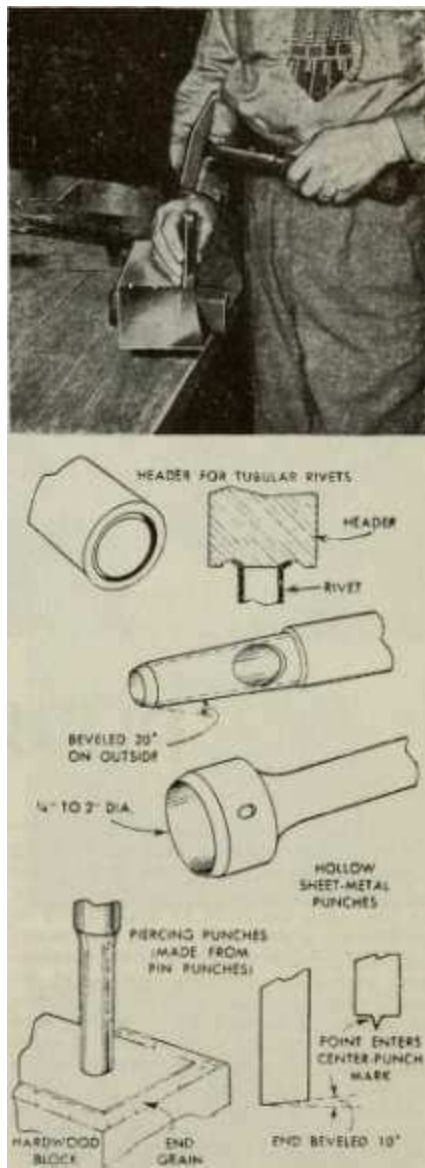
TAIL IV! TIMES RIVET DIA.

holes can be brought into line and the bolt inserted.

Bushing punches, or drivers: Small bushings usually are inserted or driven out with a bushing punch, or driver, as in the upper details above. Generally these punches have stepped shanks of two or more diameters and are supplied in a variety of sizes. The important thing in driving bushings is to use a punch of the correct size. If the punch is too small, the end of the bushing may be upset or burred.

Riveting punches, or sets: The combination setting and heading punch shown in the lower details above is widely used in hand riveting. It is rectangular in shape and has a hole drilled in the end to take the tapered point of the solid rivet in a fairly snug fit. A shallow concavity, or "dimple," ground in the same end of the punch is used to head the rivet after setting. Flat-headed solid rivets are backed with a rivet bolster or anvil. Round-headed rivets fit into dimples ground in the bolster. It is important that the tail of the rivet project only 1½ times its diameter after setting. If the tail is longer the rivet may split. If shorter, the upset end will have greatly lessened holding power.

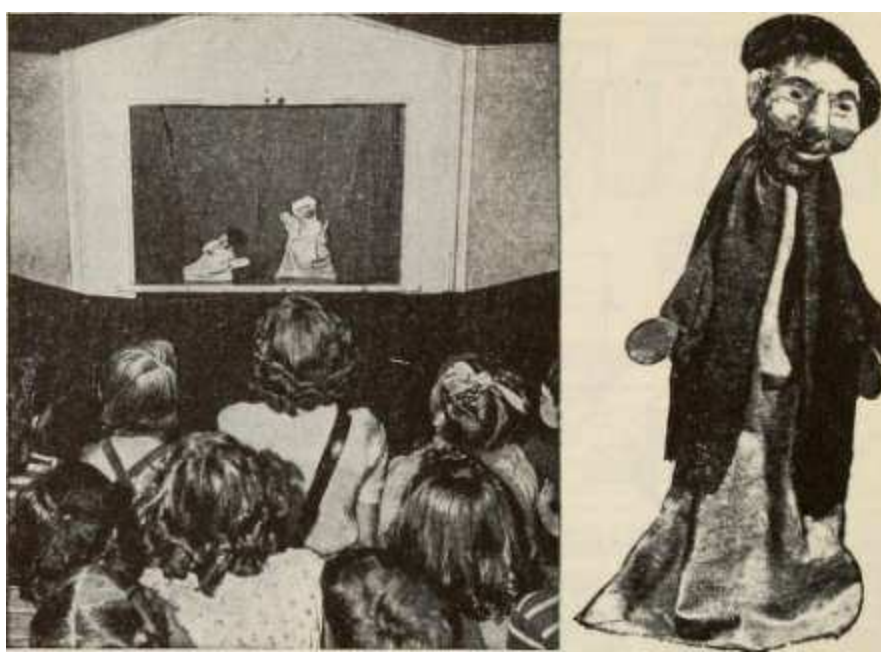
Tubular-rivet header: Tubular rivets, and also split rivets, are headed with a tool like that shown in the upper details at the right. The header is turned with a short projection at one end which enters the hollow end of the rivet. A concave groove turned in the end of the header at the base of the projection turns, or rolls, the rivet edge down to form a clinching rim. On soft materials, such as fabrics and leather, thin washers are sometimes placed over the end of the rivet before clinching.



HARDWOOD BLOCK

END BEVELED 10°

Hollow and piercing punches: The center and lower details above show two common types of hollow punches and the solid piercing punch. The hollow punches have beveled cutting edges and are made for both metals and fabrics. Piercing punches are used to form rivet holes and for decorative work on sheet metal. They must be sharpened often at the bevel indicated. * * *



PUPPETS

TRIGGERED by their popularity on television, hand puppets are fast becoming the rage among the youngsters of the country. Not only are the puppets entertaining but they give the child an opportunity to combine his artistic talents with craftsmanship. Unlike the more elaborate marionettes with their movable joints and involved string arrangements, these puppets are easy to make and the presentation of a show requires little more than a stage front with a curtain backdrop behind which the operator can stand.

Although the actual fashioning of the puppets is surprisingly simple, there is no limit to the variety of characters that can be created with the aid of a little imagination. The puppets consist basically of a head and two hands which are joined together with an appropriate costume. The head, modeled over a hollow core, is placed on the index finger and the arms are mounted on the tips of the thumb and little finger of the operator's hand.

The center of attention and, therefore, the most important part of the puppet is the head. A mache type of material, which

must be specially prepared, is used to model the head, the primary ingredient of the substance being wood dust. Note that this is not ordinary sawdust but the fine dust collected from a sanding machine. Each puppet head requires about a heaping cupful of the wood dust. This is thoroughly mixed with a flour-and-water paste by adding the dust to the paste and working it in until the mass is of sufficient consistency to permit modeling with the hands. It is recommended to use hot water for mixing the paste, primarily because it is more comfortable to work the warm mixture by hand. As soon as the modeling material attains the desired consistency, the mass is applied around a paper core and shaped to the features of the puppet.

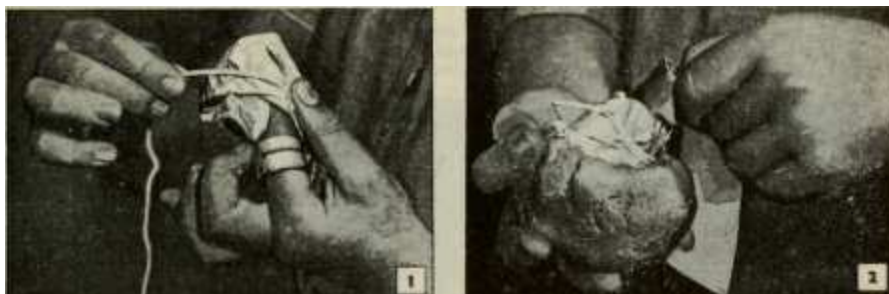
To make the core, cut a piece of heavy wrapping paper into a strip approximately 2 in. wide and 18 in. long. Wrap the paper loosely around your index finger to form a cylinder and then fasten it with a strip of cellulose tape or gummed paper. Leave the cylinder on your finger, crumple half of a paper towel and then tie it around the upper portion of the cylinder with a piece

of string, as in Fig. 1. Follow by applying the mache over the towel, as shown in Fig. 2, modeling the features of the head as in Fig. 3. The reason for placing the crumpled paper towel around the upper half of the core is to provide a rough surface which the mache will grip securely when it hardens. Thus, it will not slip off the core. Note that in modeling the head, a collar of mache is formed around the lower portion of the core. It is necessary that this be done, as the collar allows the puppet's costume to be fastened with a drawstring, as in Fig. 7. After modeling the head, set it aside to dry for about two days and when it has hardened, sand the contours smooth with fine abrasive as pictured in Fig. 4. As the mache has a high wood content, you will find it easy to sand. Painting the head is the next step and, when doing this, keep in mind that the audience must be able to see the features from a considerable distance. For this reason, use bold lines and colors, Fig. 6, making up the puppets just as carefully as circus clowns. A standard doll wig, or a homemade one of fur or carpeting is glued to the head. However, if a rather large hat is part of the costume, hair can



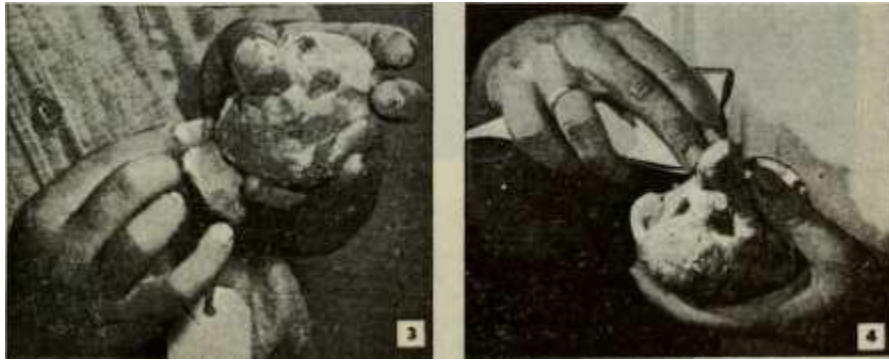
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Puppet and puppeteer ready for the next performance



Crumpled paper towel tied around end of cylinder provides form over which puppet's head is modeled

Head is fashioned from a specially prepared mache type of material, utilizing a cupful of fine wood dust



Collar molded at base of the head permits attaching costume simply by tightening drawstring at the neck

After the mache has dried for two days, the features are carefully sanded with a very fine abrasive paper



The rear view, left, shows how puppet's costume hides hand and arm of operator. The head of the puppet is painted boldly and in bright colors, as shown above

Below, left, the drawstring at the neck of the costume is pulled taut for attaching to-collar on head. Below, arms and head fit on finger tips of puppeteer



be simulated by painting over the mache. The arms of the puppet are made of wrapping paper in the same way as the core of the head. Wooden ice-cream spoons taped or glued to the cylinders, as in Fig. 8, form the hands. These can be notched to simulate fingers or left plain and painted to suit. -Suitable costumes for the characters

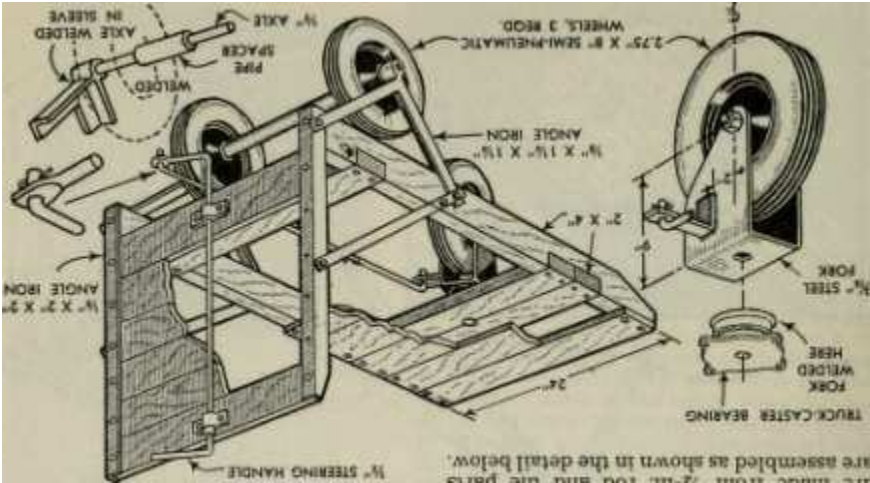
can be cut and sewed together from cloth remnants, using gay or subdued colors to conform with the personality of the puppet being created. As mentioned before, the neck of the garment as well as the arms are secured with drawstrings. Note in Fig. 5 how the long costume of the puppet hides the operator's hand and arm.

PUSH TRUCK

r)UILT by Leonard Hammerschmidt, '-' California poultry rancher, this labor-saving push truck can be used by farmers everywhere to simplify the handling of sacked feeds or small grains in the narrow feeding alleys of dairy barns, farrowing houses, and large granaries. A single caster wheel in front is controlled by a steering arm mounted on the rear panel of the platform body. Hardwood is used for the sills-and cross members of the platform frame. The cross members are mortised the full thickness into the sills and fastened with bolts. The rear-axle brackets are each made from two piecfes of angle iron and a sleeve welded together as in one of the details below. After assembling the wheels on the axle with a pipe spacer, the axle is welded to the sleeves at each end. To assemble the front caster, the fork is cut from a stock truck caster of the swiveling type and the ball-bearing swivel assembly is welded to a new and larger fork made from ■"i(-in. sheet steel. Note that the swivel is located on the fork 2 in. off-center from the wheel axle. Before bolting the wheel assembly in place, an arm bent from flat iron is welded to one side of the fork and drilled at the outer end to take the steering rod. Angle-iron uprights are now bolted to the rear ends of the sills and braced as shown. The platform frame is then covered with 1 X 4 or 1 X 6-in. boards and spaced holes are drilled in the uprights for small screws used to attach the boards making up the back panel. The steering arm and handle are made from y2-in. rod and the parts are assembled as shown in the detail below.



2" STEERING HANDLE.



AXLE WELDED IN SLEEVE

QUILTING FRAME, ^>

By removing eight wing nuts, the cross braces and legs can be folded flat against the frame for storage. The legs and braces may be of common pine, but hardwood should be

used for the frame rails and ratchet wheels. The tenoned ends of the rolls can be formed by gluing short dowels in centered holes, or the stock itself may be rounded at the ends with a wood rasp. Fasten quilt by sewing tope to two edges and tying to the rails

CARRIAGE BOLT

r.

S'A"!

i:

---:Cik: 4'/e''

%'' X 36''

% "X1%"

% " X 1 Va " X 37 "

2"X2"X90"-

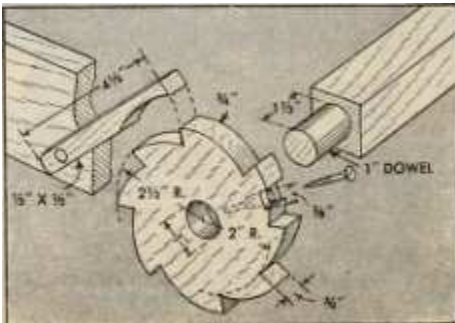
. WING NUT

8%

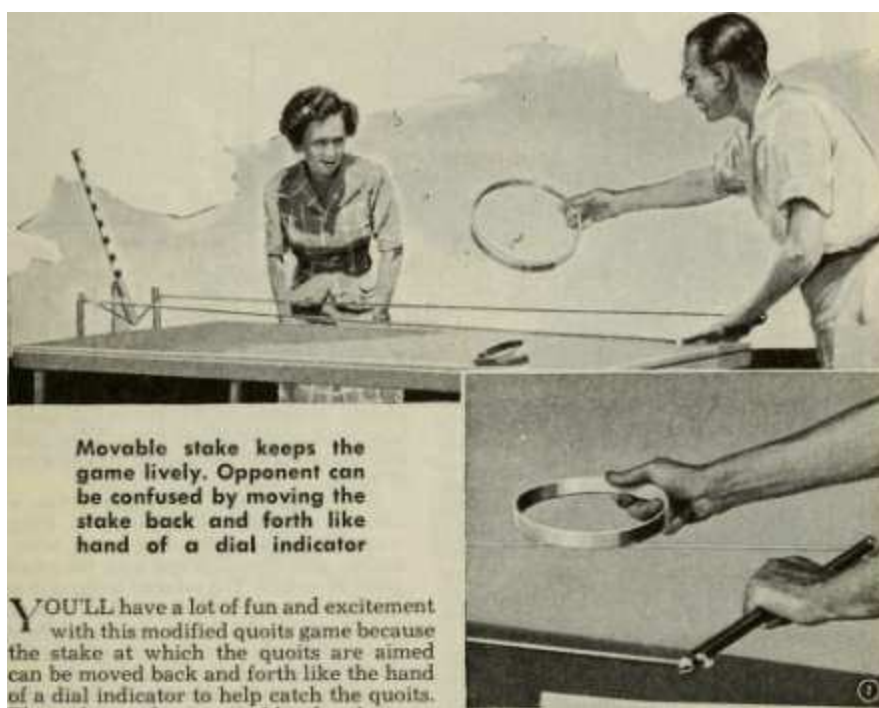
$$T_{-}^{\wedge}$$

•31"

% " SPACER BLOCK



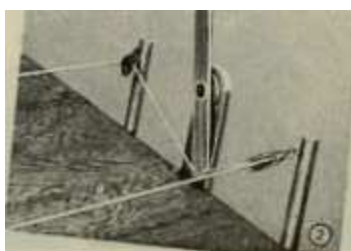
QUOITS

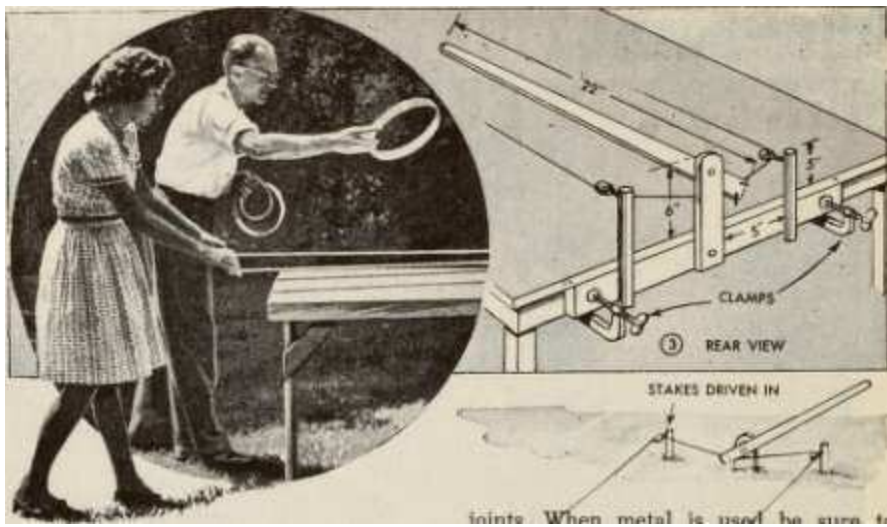


Movable stake keeps the game lively. Opponent can be confused by moving the stake back and forth like hand of a dial indicator

YOU'LL have a lot of fun and excitement ^ with this modified quoits game because the stake at which the quoits are aimed can be moved back and forth like the hand of a dial indicator to help catch the quoits. The stake can be operated by the player as in Fig. 1, or by a teammate as in Fig. 3. In the latter case, it is permissible and also productive of better results for the player moving the stake to use both hands. When only two persons are playing, each player must throw with one hand and move the stake with the other one. When two or more persons are playing as a team the player operating the stake stands to one side of the table, taking care not to move the stake unnecessarily in the excitement of play.

The game can be played indoors or out. If played indoors, the equipment can be mounted on a table by means of screws or clamps. The larger the table the better, but one measuring less than 3 by 6 ft. should not be used. Part of the fun lies in the fact that it is impossible for a player who is both throwing and moving the stake to step in closer than he should, for when he attempts to do so the cords slacken and the stake cannot be moved. This is an especially important point when the game is played outdoors with no table. When two players are paired off, one to throw and one to move the stake.





CLAMPS (D REAR VIEW

STAKES DRIVEN IN

both should stand an equal distance from the stake. Fig. 2 shows how the stake is rigged on a table, and Fig. 3 gives the dimensions. The rigged assembly consists a wood block to which the stake is pivoted and two short dowels to support the pulleys, all being nailed to a wood shingle. Long cords tied to the bottom of the stake and run through the pulleys complete the assembly. A length of Vaseline or broomstick tied to the free end of the cords simplifies operation of the stake.

The quoits can be made of 1 by 3/4-in. strips of hardwood. Soak them in water bend them into hoops with the ends overlapping and lash the joints with cord. Make the sizes, 6, 9 and 12 in. in diameter.

One of each size is enough for

to play, but a few sets will be

• If it is useful. The quoit also can be

made of strips of sheet metal

with rivets in the overlapped



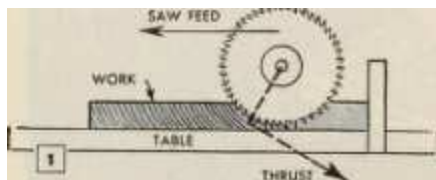
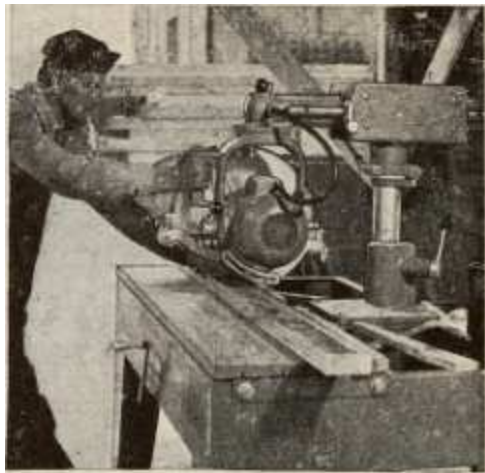
joints. When metal is used be sure to smooth the sharp edges. If the game is played outdoors on the round, double the

size of all equipment and attach the pulleys and pivoted stake to stakes driven into the ground.

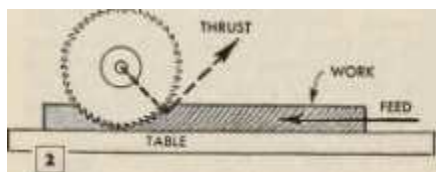
Each player has three shots, one with each of the three sizes of quoits. Ringing with the largest counts five points, with the middle size, 10 points and with the smallest quoit 20 points. The winner is the one with the highest score at the end of seven rounds. In the event of a tie at the end of the seventh round, continue play. The throwing player has the right to choose which of his teammates shall move the stake for him. The throwing player must not step closer to the stake than the player who is moving it. A chalkline or a tape is useful in keeping the thrower at the proper distance. If he steps over the line it is a foul and his side is penalized 10 points.



"Horse Race" Adds Excitement to Quoits Game



CROSSCUT—Action of blade pushes work down on table and back to fence. Dull saw tends to climb



RIP—Feed is against rotation of blade. Dull saw has tendency to lift the work from the table

WORK-. i \sqrt{y} I

n

a-

THRUST

NEVER rip in same direction as saw rotation. This is same action as crosscut but lack of backstop causes saw to hog the work without control

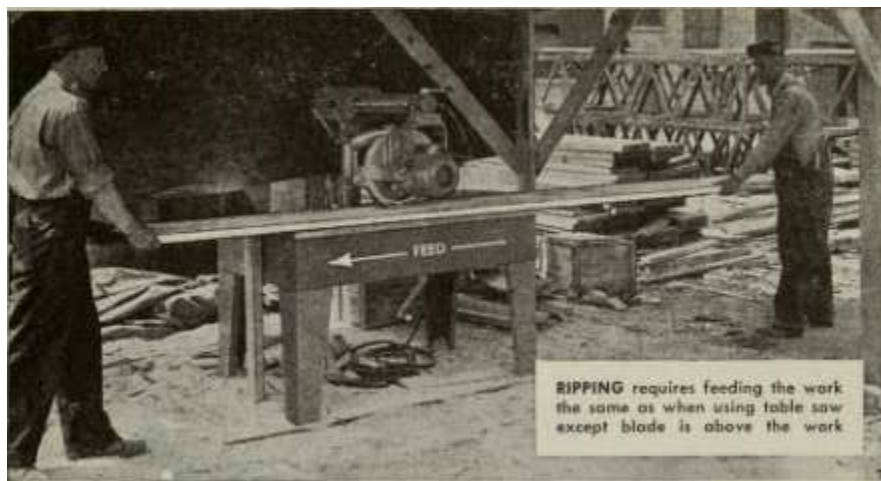
CROSSCUTTING is job radial saw does best. Work remains stationary and saw is pulled through to cut

RADIAL SAW slides along an over-head arm, and the saw itself can be rotated in a full circle. These adjustments permit a wide variety of operations, although the one job the radial does best is plain crosscutting, either square or at an angle. In this operation the work remains stationary while the saw is pulled through it. Radial saws are available in a range of sizes from 1/2 to 10 hp., the smaller sizes of 1/2 hp. or less being most

popular. Motors are commonly 3450 r.p.m. which gives a constantly increasing rim speed with larger size saws; a 12-in. blade will have a rim speed of about 11,000 f.p.m.

Saw action: The radial saw is a push-through saw and uses climb feed for cross-cutting. In this action, the saw is moved in the same direction as its rotation, as shown in Fig. 1. The action in ripping is the same as that of a table saw except the saw is above the work. Fig. 2. The saw has a slight lifting action which is negligible with a sharp blade but increases as the blade becomes dull. It is common practice to swing the infeed side of the guard nearly in contact with the work to prevent lifting. Ripping must never be done in the same direction as saw rotation. Fig. 3. This is climb feed and, without the backstop as in cross-cutting, the hogging of work is violent and uncontrolled, especially with a dull blade.

Choice of method: Your first cut with the saw will pose the question of right-hand feed, Fig. 4, or left-hand feed. Fig. 5. You will probably use left-hand feed because it puts the holding (right) hand on the side away from the saw and is obviously safer. However, the right-hand feed is more

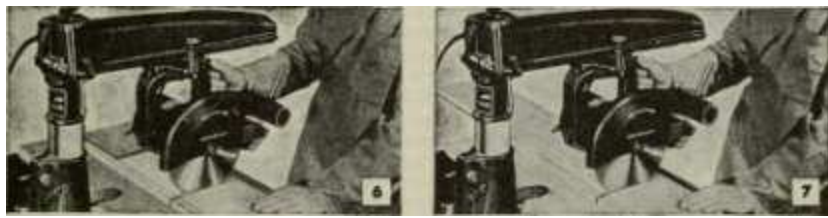


__ requires feeding the work the same as when using table saw ^s, except blade is above the work 't'



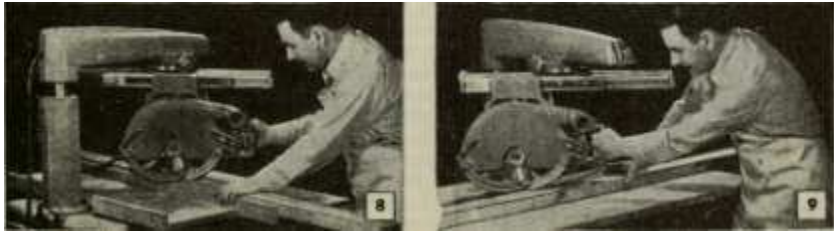
RIGHT-HAND FEED is the natural and practical LEFT-HAND FEED offers extra safety and is

position for crosscutting most types of work often the best feed for use on all awkward work



LONG END TO LEFT permits the left hand to hold solid portion of work safely and securely

LONG END TO RIGHT is a poor way to operate saw when left hand must hold short cutoff



LEFT-HAND MITER is the most comfortable to use on all angle cuts up to approx.. 60 deg.

RIGHT-HAND MITER is an awkward position although it is useful in cutting angles over 60 deg.



practical, more comfortable, and you will quickly adopt this system.

A choice that should be obvious is to hold onto the long part of work when making a

cutoff? as shown in Figs. 6 and 7. When it comes to miter cuts, you will find the left-hand swing more comfortable for most work, Fig. 8, although the right-hand miter, Fig. 9, is often the best choice when cutting at an extreme angle. In ripping, you have a choice of inside rip or outside rip, these terms indicating whether the saw is toward the column or away from it. Fig. 10 shows outside rip and the top photo on the preceding page shows an inside rip. Most workers prefer outside rip although it is a wrong hand operation when compared with a rip cut made on a table saw.

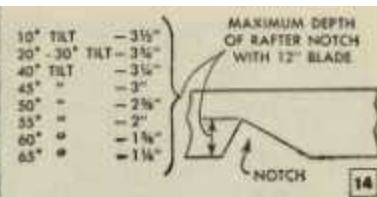
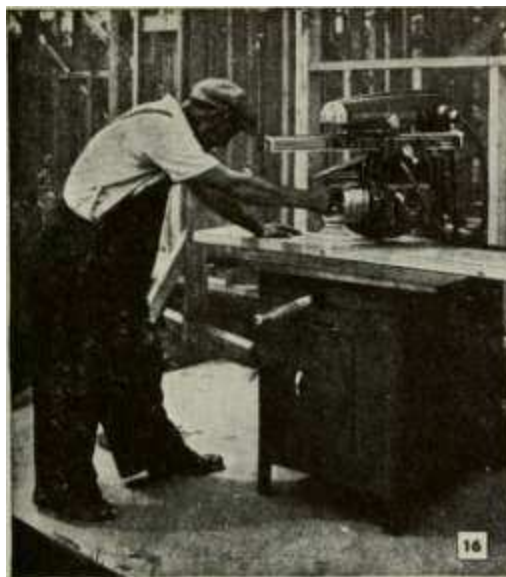
Installation: For shop work, the radial saw is best installed along a wall. You can do what you like in the way of extension tables and extra fixtures, Fig. 10. In all cases, a "wear" table of plywood or hardboard should be nailed over the permanent front table as in Fig. 11. This takes the saw cuts and keeps the permanent table from being chewed up. The fence is any straight stick of wood held in place with a wedge at either end as in Fig. 12. A new saw should be carefully adjusted when set up, including leveling of table, squaring of crosscut, Fig. 13, etc.

Cutting rafters: The radial saw is "tops" for building construction where most of the lumber is dimension stock that needs only cutting to length. Roof framing is typical of this work. Table on page 151 shows required i-after angles. For example, suppose you are framing a roof of % pitch. Any plumb (vertical) cut is made with the saw set at 33% deg. on the miter scale, while any level cut is made with a miter swing of 56y4

MAXIMUM DEPTH

OF RAFTER NOTCH

WITH 12" BLADE



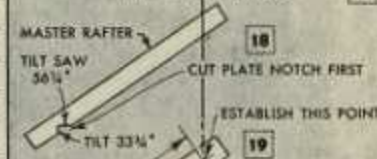
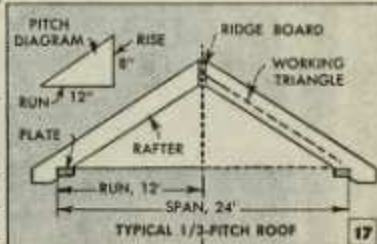
SAW IS TILTED to same angles for rafter notching but note that work is cut on edge

BUILDING CONSTRUCTION is field for radial saw. Saw is swung to desired miter to make both plumb and level cuts.

TABLE OF COMMON RAFTERS

| RISE PER FT. OF RUN | PITCH | SAW SETTING* | | LENGTH PER FT. OF RUN |
|---------------------|-------|--------------|-----------|-----------------------|
| | | PLUMB CUT | LEVEL CUT | |
| 1" | 1/24 | 4 1/4" | 85 1/4" | 12.042" |
| 2" | 1/12 | 9 1/4" | 80 1/4" | 12.166" |
| 3" | 1/8 | 14" | 76" | 12.369" |
| 4" | 1/6 | 18 1/4" | 71 1/4" | 12.649" |
| 5" | 5/24 | 22 1/4" | 67 1/4" | 13" |
| 6" | 1/4 | 26 1/4" | 63 1/4" | 13.416" |
| 7" | 7/24 | 30 1/4" | 59 1/4" | 13.892" |
| 8" | 1/3 | 33 1/4" | 56 1/4" | 14.422" |
| 9" | 9/24 | 37" | 53" | 15" |
| 10" | 5/12 | 39 1/4" | 50 1/4" | 15.621" |
| 11" | 11/24 | 42 1/4" | 47 1/4" | 16.379" |
| 12" | 1/2 | 45" | 45" | 16.971" |
| 13" | 13/24 | 47 1/4" | 42 1/4" | 17.692" |
| 14" | 7/12 | 49 1/4" | 40 1/4" | 18.439" |
| 15" | 15/24 | 51 1/4" | 38 1/4" | 19.209" |
| 16" | 2/3 | 53" | 37" | 20" |
| 18" | 3/4 | 56 1/4" | 33 1/4" | 21.833" |
| 20" | 5/6 | 59" | 31" | 23.324" |
| 24" | FULL | 63 1/4" | 26 1/4" | 26.833" |

*DIRECT SETTING TO TILT AND MITER SCALES WHEN 0° IS NORMAL SQUARE CROSSCUT. OTHERWISE TRANSPOSE COLUMNS



SAW 33 1/4° MITER FIRST—THEN CUT OFF 1/4 THICKNESS OF RIDGE BOARD

•DIRECT SETTING TO TUT MAI SQUARE CROSSCUT.

AND MITER SCALES WHEN OTHERWISE, TRANSPOSE

PITCH OF ROOF AND RUN OF RAFTERS ARE ONLY INFORMATION REQUIRED TO DETERMINE ANGLES OF CUTS AND RAFTER LENGTH FROM TABLE AT LEFT. TABLE COVERS FROM 1/24 TO FULL PITCH

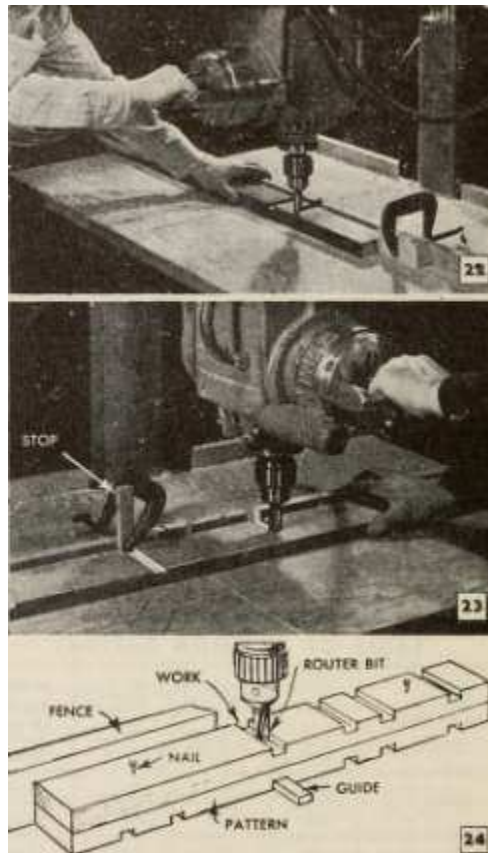
OUTING is second only to crosscut sawing in radial-jw operations. The stop prevents work creeping

eg. If you have to do notching for the late, the angles are the same except the rork stands on edge while the saw is tilted, ig. 15. This operation has depth limitation, ig. 14, but can be used for a large number f jobs involving pitches from Vs to %. It ; usually necessary to

remove the saw guard when making these angle cuts. While the cut itself is no more dangerous than a plain crosscut, it is sensible practice to clamp the work to the fence, Fig. 15, for this "bare blade" cut.

The table also gives a multiplying factor which enables you to find the length of any after for any pitch. For a 12-in-12-pitch roof, the factor is 14.422 in. When this figure is multiplied by the run of the rafter, it gives the after length between two specific points, as shown in Fig. 19. The working triangle, Fig. 17, which uses the run as a base, can be located at any convenient point, that is, inside of plate or outside of plate or some intermediate point. The run measurement is commonly made to outside of plate since this is usually an even figure and simplifies the job of multiplying. Follow the example from Figs. 17 to 20, inclusive, and you will see how this works.

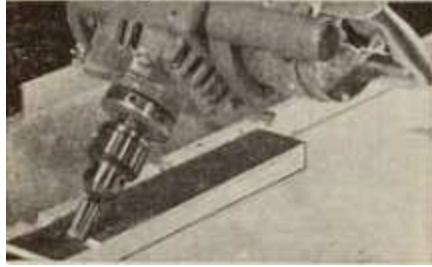
A master rafter is always made first, starting with the plate notch. Once this is cut to required length, it is used as a guide for setting stops. The plate notch is cut last since the end cuts must butt against the top, Fig. 15. When a rafter notch is too



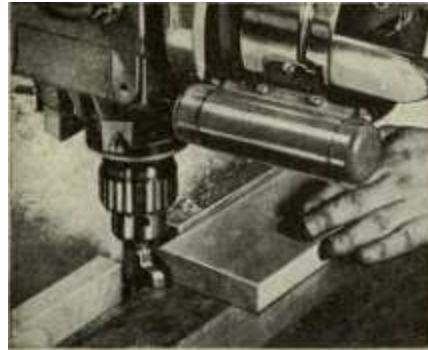
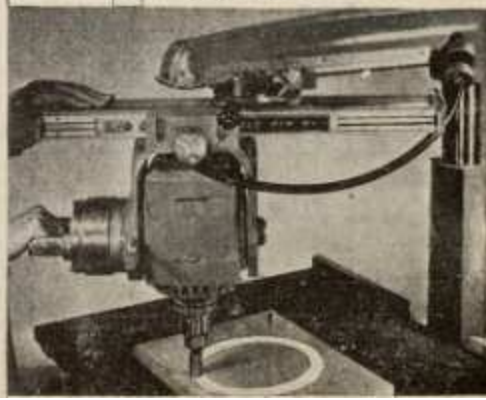
FIRST PIECE is used as template for routing similar piece, guide strip being located below bit

A master rafter is always made first, starting with the plate notch. Once this is cut to required length, it is used as a guide for setting stops. The plate notch is cut last since the end cuts must butt against the top, Fig. 15. When a rafter notch is too

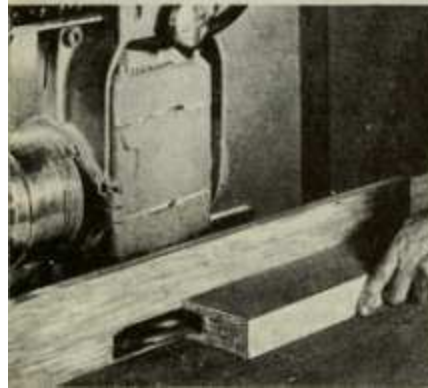
25 V-GROOVING



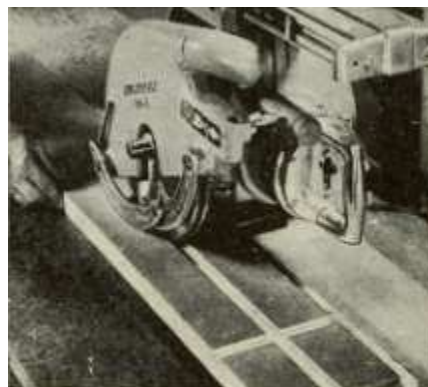
26 CIRCLE ROUTING



SIMPLE SHAPING IS DONE EASILY



WIDE RABBETS CUT WITH SAW HORIZONTAL



CUTOUT FENCE IS USED FOR GROOVING

DADO HEAD MAKES VARIETY OF CUTS

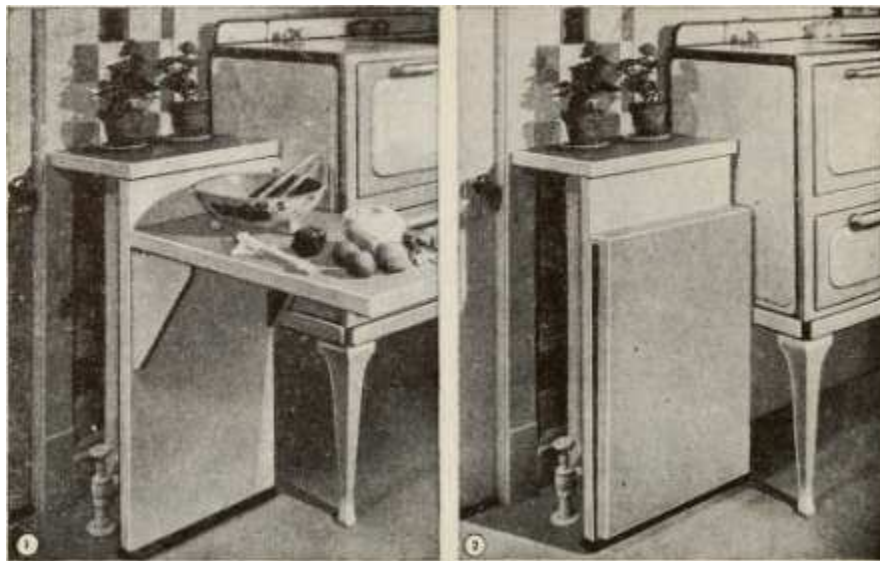
deep for edge-cutting, it is often practical to make the cut as far as possible in the miter position, Fig. 16. This will leave a small uncut section of wood which is easily completed

with a handsaw.

Routing: Other than crosscut sawing, routing is the handiest job done on the radial. The mounting is rigid, the motor husky; you can swing bits up to $\frac{1}{2}$ -in. dia. at $\frac{1}{8}$ -in. depth per pass. Cross-routing can be done from back to front or front to back. Routing from the back, Fig. 21, is the most practical since the fence gives support for the starting cut which, with front to back routing, tends to tear the wood on entry. When you cross-rout from the back, a stop should be used at the right end of work. Fig. 22, to eliminate creeping of the work. If you rout from the front, the stop should be at the left end.

Cross-routing of equally spaced grooves is done easily by using a stop clamped to the fence at the required distance from the bit. Fig. 23. This not only spaces the cuts but also prevents creep. When two similar pieces of odd-spaced work are required, as

for a shelf, the second piece is accurately routed by using the first piece as a pattern which fits over a guide strip located directly below the bit, as shown in Fig. 24. Routing is excellent for V-grooves, Fig. 25. The action here is more side than end cutting, making the preferable feed from front to back, as shown. Radial saws of the center-pivot type can be adjusted to rout circles, as shown in Fig. 26. Note that left-hand bits are needed for all routing operations. When routing with hand feed, that is, feeding the work along the fence, the feed is always from right to left, just the reverse of the drill press, which uses right-hand bits. Like the drill press, the idea is to have the bit rotation force the work against the fence. Other jobs: Once you start using a radial saw you will find it capable of doing a hundred and one different jobs. The photos above picture four examples. A speed of 3450 r.p.m. is a practical working speed for an 8-in. sanding disk or a 6-in. grinding wheel. The tilt adjustment is especially useful for precision grinding jobs, such as saw sharpening.

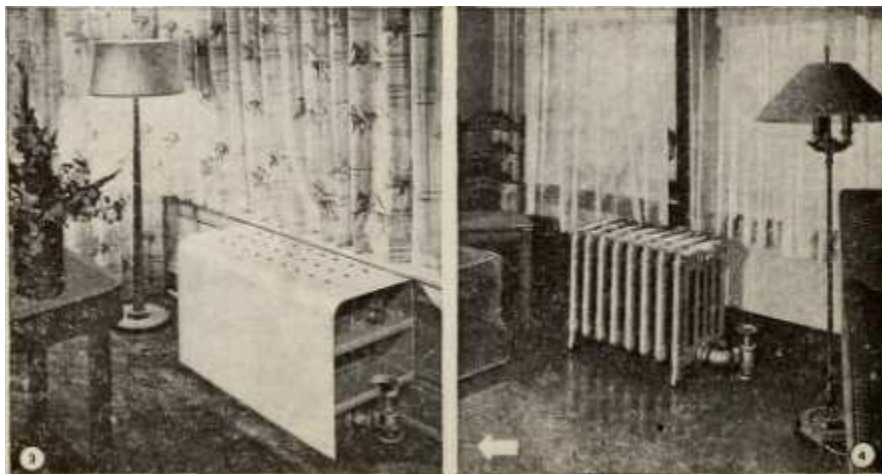


AN acknowledged eyesore around the home, uncovered radiators are one of those things that everybody talks about but nobody does anything about. Of course, you can buy covers, but with a little ingenuity you can make some that will harmonize with, and

complement, the rest of your furniture. The photos suggest a few ways of covering radiators to improve the appearance of the room. With the addition of the covers, radiators will also act as convectors, the "stack height" or "draft head" being due to the fact that the front and sides are partly

covered. Although the height, width and depth of radiator sections are standardized, the number of sections in each unit varies and, for that reason, no dimensions are given. However, for the sake of appearance, the covers should extend beyond any valves, vents and traps.

The cover shown in Figs. 1 and 2 performs a dual function: it masks the radiator and serves as a table. Insulating board is placed next to the radiator under the wooden top and face to prevent warping of the wood. Linoleum is used as a surface



RADIATOR COVERS



for the table and top of the cover. Note that instead of using legs to support the table in the raised position, two brackets fold out to support it. Circulation of air is through the open ends. Fig. 4 is the "before" and Fig. 3 the "after" view of a living-room radiator that is

covered with pressed board bent to shape and lined with insulating board. Reinforcement at the ends increases the strength of the cabinet. Perforations are drilled in the top to increase the circulation of air. Sheet metal could have been used instead of wood in this case.

Horizontal lines are emphasized in the design of another type of living-room cov-

Photos courtesy U. S. Gypsum Ca

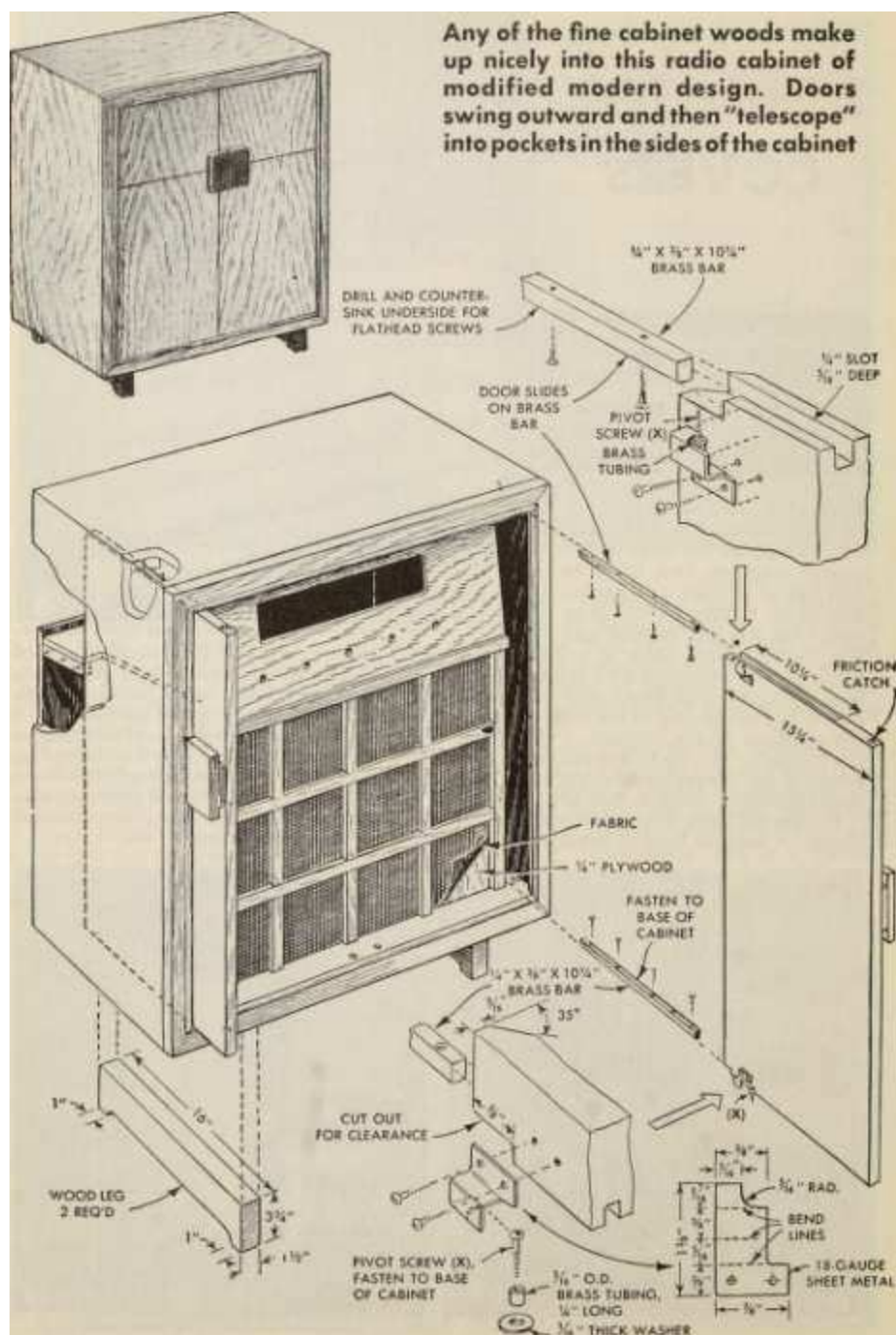
er shown in Fig. 5. It is constructed of wood and insulating board and lined with grass cloth, the latter being porous enough to permit free circulation of air. In Figs. 6 and 7 are shown the before and after views of a bedroom radiator. Like the one in Fig. 3, it is formed of pressed board and lined with insulation. The top of this one also has perforations. All units are finished with a high-gloss enamel.



Any of the fine cabinet woods make up nicely into this radio cabinet of modified modern design. Doors swing outward and then "telescope" into pockets in the sides of the cabinet

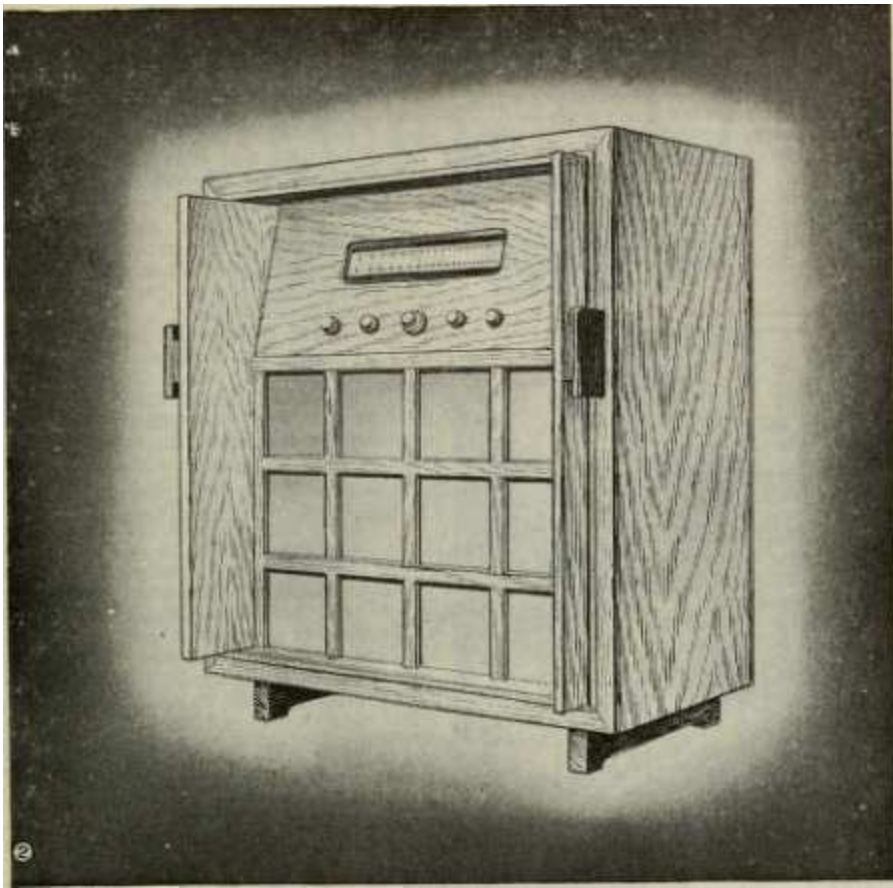
1 1/2" X 1/4" BRASS BAR

1/4" SLOT DEEP



WOOD 2 REQ

18-GAUGE SHEET METAL



RADIO CABINET

WITH the exception of the novel "telescoping" doors, which open out and then slide back into pockets, this floor-type radio cabinet is almost as simple and easy to build as a box. Character and individuality of design are added by beading around the double-door opening, built-up door handles and one-piece inset wood legs or feet. Absence of curved parts on the exterior of the cabinet gives the whole job a pleasing plumbness of line that appeals to both the craftsman and the home decorator.

Due to the width of the sides, top and bottom, it will be necessary to build up to the required widths by edge-gluing several pieces together. Select the wood for quality and grain and cut all the pieces slightly longer and wider than the finished dimensions to allow for fitting. The kind of wood to use depends on the finish you desire. Plain oak will take a beautiful limed finish, which is especially popular on this modified modern design. Any of the other fine cabinet woods are, of course, suitable for finishing in the natural color, bleached or stained. However, if you like an enamel finish, then use a close-grained wood such as birch, gum or poplar.

When clamping edge-glued work, you can save a lot of time and extra sanding by making sure that the edges are flush. Draw the bar clamps tight and then even up the edges by tapping lightly with a hammer. Wipe off excess glue with a damp cloth. Allow plenty of time for the glued joints to dry before releasing the clamps. Doors

are built up to width in the same manner, making them slightly oversize all around so

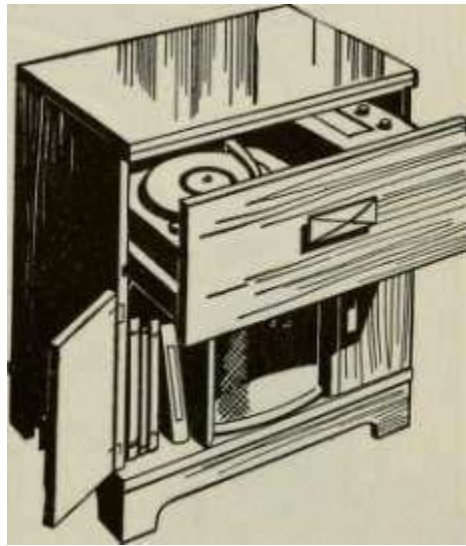
they can be trimmed to fit accurately. This done, the pieces must be sanded smooth. On glued-up work such as this it often is necessary to go over the surface with a jointer plane in order to get it perfectly flat. After planing and sanding all pieces, you're ready to cut to size and join the parts. Cut a rabbet in the back edge of the sides and the bottom piece to take the back. Mitered joints at the corner of the

cabinet give the best appearance but are more difficult to make. Clamping can be done by making four clamping cauls from 1 by 4-in. stock, each piece cut slightly longer than the width of the cabinet side pieces. Nail two 1 by 4-in. pieces together at right angles to make one caul. Then make the miter cuts on the four pieces which comprise the top, bottom and sides. Spread glue on the joining surfaces, set the parts together, block them in position and place a caul over each corner. Then draw up with eight bar clamps, two across each panel lengthwise.

Next, glue on the facing strip and beading. Fig. 1. Screw the back panel in place and the inclined shelf for the radio chassis, then the instrument panel and framework for the grille. A look at the three views in Fig. 3 will give you dimensions and location of these parts. Finally, "hang" the doors. Fig. 1 gives the details, Fig. 2 shows the doors open and Fig. 3 gives the position of the door in section. The pivot screw X is shown in position in Figs. 1 and 3. It likely will be necessary to make a trial fit in order to get the doors to work smoothly. Doors should be fitted with allowance for free movement and then finished on both sides and the edges. This adds to appearance and prevents absorption of moisture which might cause the wood to swell.

•rk'/M^W/^/A

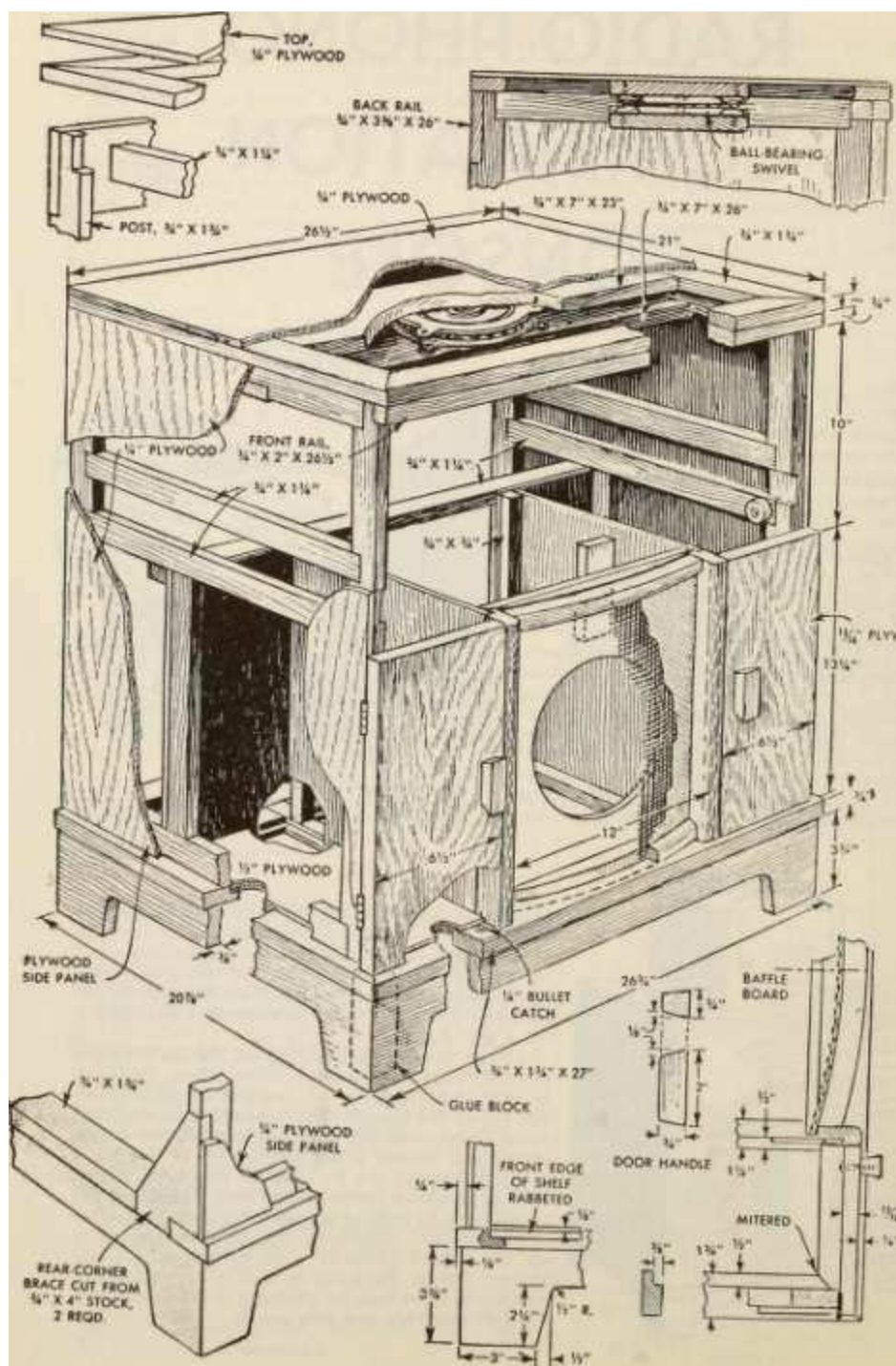
Should your record player be of the type having a self-con-



tained speaker, this can be disconnected and the lead wires run to the radio speaker. However, a switch must be installed in the lead wires from the record player. If desired, you can purchase a single larger speaker and use it for the entire combination. Your TV-radio serviceman will install it for a few dollars.

As the cabinet is likely to be the outstanding piece of furniture in your Uving room, its finish is very important. If oak, walnut or other cabinet woods are used for the exposed rails, and plywood faced with the same veneer for the doors, panels and drawer front, your choice of the many popular finishes can be applied. However, if you wish to hold the material cost to a minimum, the cabinet can be built of less-expensive birch, poplar or gum in both solid stock and plywood, covering all the visible surfaces with wood-grain plastic veneer. When finishing in this way, additional savings may be had by utihzing ^A-in. hardboard for the swivel top and side panels.

'/J!|l|l:l: il/illi;! I %■ PLYWOOD



REARCORNER
 BRACE CUT FROM
 1/2" X 4" STOCK,
 2 REQD.
 o\
 --^u-
 1/2" X 1 1/4" CLEATS -

i

1/4" X 1" CLEATS

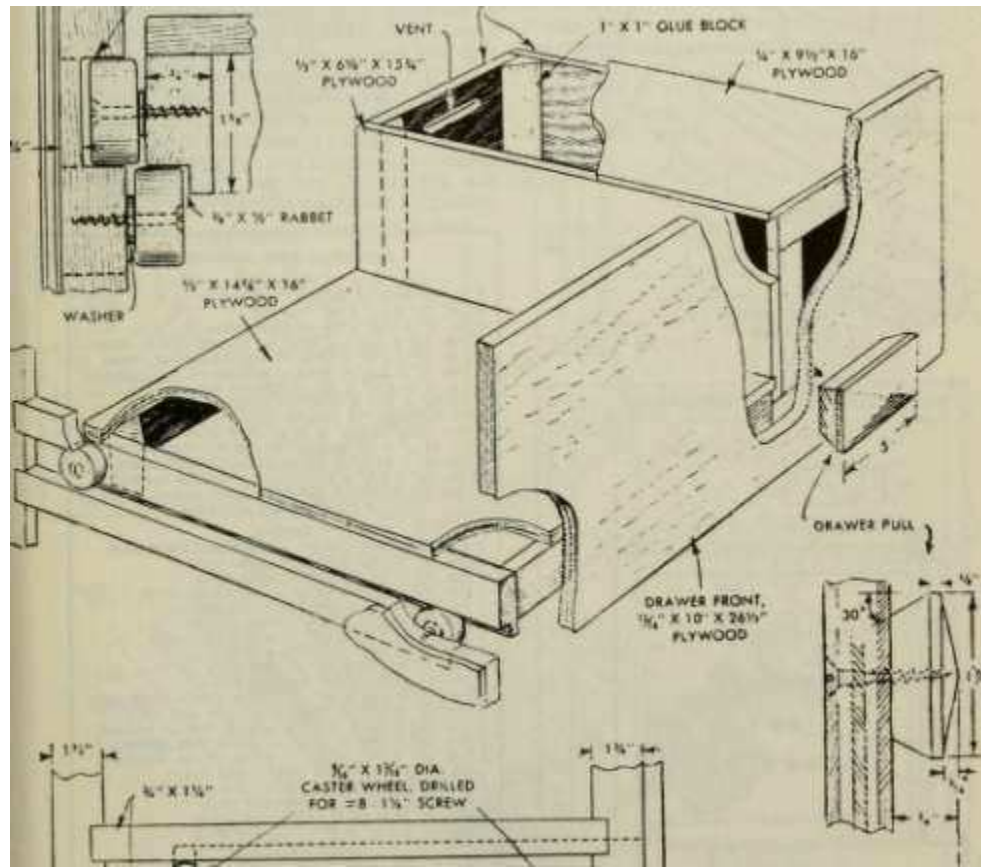
RADIO-CHASSIS BOARD 1/4" PLYWOOD

U

1/4" X 1" NOTCH CUT IN FRONT POST

1/4" PLYWOOD

1" X 1" GLUE BLOCK



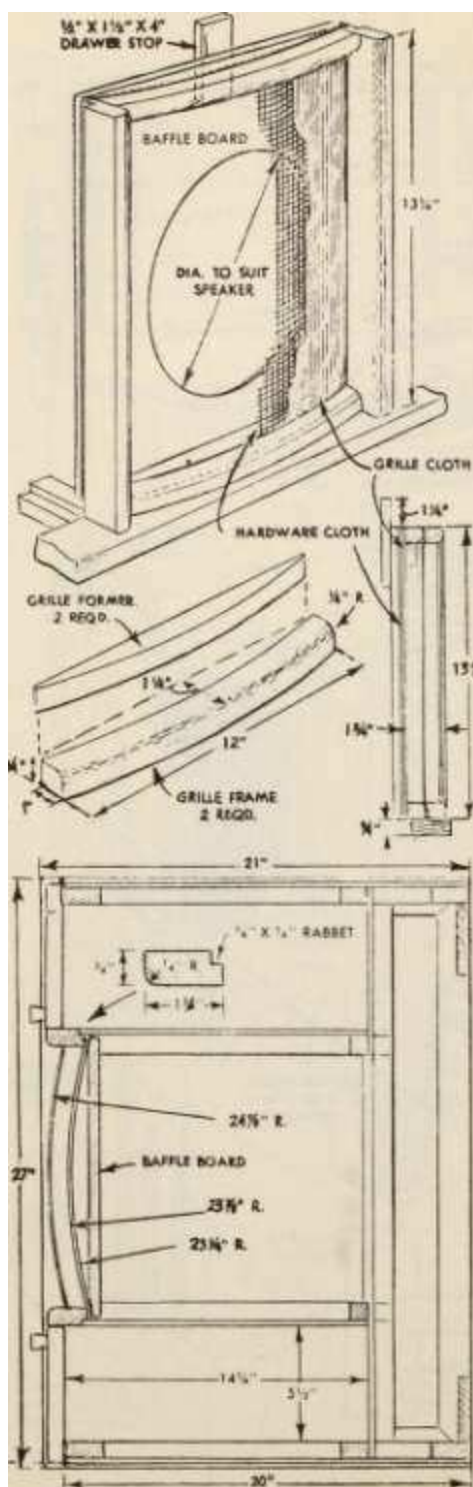
1/4" X 1/4"

1/4" X 1/4"

CASTER WHEEL. DRILLED FOR 1/8" X 1/4" SCREW

W.r.

--J



Should you wish to build the radio-phonograph combination and use it for a time without a TV set, be sure to weight the back of the cabinet, as otherwise pulling out the radio-phonograph drawer is likely to cause the entire cabinet to tip forward. Of course, this does not have to be done when the TV set is in place on the swivel top, as the cabinet was designed so that the weight of the set would counterbalance the weight of the open drawer. But, keep this in mind if the TV should be sent out for repairs.

Construction of the cabinet and the phono-radio drawer and installation of the swivel top and caster guides is apparent from the details. Note that the upper guide rails hold the drawer in a level position when extended, and that a vertical stop is screwed to the baffle board after the drawer is installed. The plywood record-changer base is drilled to suit the particular changer and the top panel of the radio compartment is drilled and cut out to

take the radio dial and knobs. The radio chassis is mounted on a plywood chassis board, which is bolted to the side panel of the drawer. Flat-headed stove bolts are set permanently in the side panel, and the chassis board is drilled so it can be slipped over the bolts.

MATERIAL YOU WILL NEED

Plywood

1 pc. $\frac{1}{4}$ " X 21" X 26 $\frac{1}{2}$ " — top

2 pes. $\frac{1}{8}$ " X 20" X 24" — sides

1 pc. $\frac{1}{4}$ " X 9 $\frac{1}{2}$ " X 16" — dial panel

2 pes. $\frac{1}{4}$ " X 13 $\frac{1}{4}$ " X 13 $\frac{3}{4}$ " — album-comp. sides 2 pes. $\frac{1}{8}$ " X 14 $\frac{1}{4}$ " X 13 $\frac{3}{4}$ " — album-comp. backs

2 pes. $\frac{1}{2}$ " X 5 $\frac{1}{2}$ " X 14 $\frac{1}{4}$ " — album-comp. bottoms 1 pc. $\frac{1}{2}$ " X 16" X 16" — drawer side 1 pc. $\frac{1}{2}$ " X 17 $\frac{1}{4}$ " X 22 $\frac{3}{4}$ " — drawer back

1 pc. $\frac{1}{2}$ " X 16 $\frac{1}{2}$ " X 15 $\frac{3}{4}$ " — drawer partition

2 pes. 1 $\frac{1}{2}$ " X 6 $\frac{1}{2}$ " X 13 $\frac{1}{4}$ " — doors

1 pc. $\frac{1}{8}$ " X 10" X 26 $\frac{1}{2}$ " — drawer front

1 pc. $\frac{1}{2}$ " X 14 $\frac{3}{4}$ " X 16" — phonograph board • 1 pc. $\frac{1}{8}$ " X 7 $\frac{1}{4}$ " X 14" — radio-chassis board • 1 pc. $\frac{1}{2}$ " X 12 $\frac{3}{4}$ " X 13 $\frac{1}{4}$ " — baffle board

* Fir Plywood Suitable

Lumber

2 pes. 3 $\frac{1}{2}$ " X 3 $\frac{3}{4}$ " X 26 $\frac{1}{4}$ " — front and back base 2 pes. 3 $\frac{1}{2}$ " X 33 $\frac{1}{4}$ " X 20 $\frac{1}{8}$ " — side base

2 pes. 3 $\frac{1}{4}$ " X 13 $\frac{1}{4}$ " X 27" — base rails

2 pes. 3 $\frac{1}{4}$ " X 13 $\frac{1}{4}$ " X 21 $\frac{1}{8}$ " — side base rails

1 pc. 3 $\frac{1}{2}$ " X 13 $\frac{1}{2}$ " X 26 $\frac{3}{4}$ " — front rail

2 pes. 3 $\frac{1}{4}$ " X 13 $\frac{1}{4}$ " X 26 $\frac{1}{2}$ " — top frame

2 pes. 3 $\frac{1}{4}$ " X 13 $\frac{1}{4}$ " X 21" — top side frame 4 pes. 3 $\frac{1}{4}$ " X 13 $\frac{1}{4}$ " X 24" — posts 8 pes. 3 $\frac{1}{4}$ " X 1 $\frac{1}{4}$ " X 18" — side rails

1 pc. 34" X 3'8" X 26" — back rail

2 pes. 34" X 114" X 26" — album-comp. back rails 2 pes. 34" X 1',4" X 11',2" — album side rails

2 pes. 3^" X 34" X 13V4" — album corner braces 2 pes. 34" X 13,4" X 131,4" — grille side posts 2 pes. 34" X 134" X 12" — grille frame 1 pc. 34" X 7" X 23" — swivel-top brace 1 pe. 34" X 7" X 26" — swivel-top mount

1 pc. 34" X ITs" X 5" — drawer pull

2 pes. 3,4" X 3,4" X 2" — door handles

1 pc. \<i" X 1',2" X 4" — drawer stop

Miscellaneous

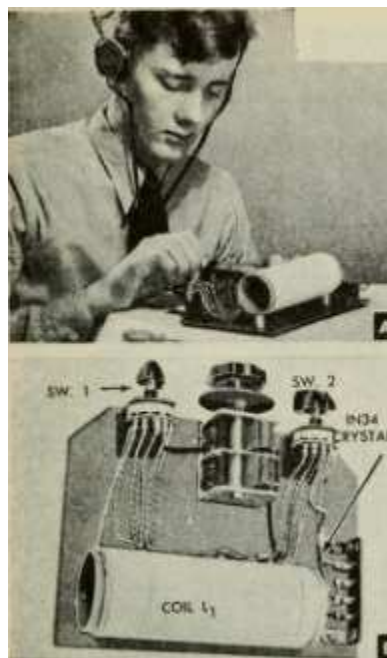
4 Hi" X IV2" butt hinges

2 >4" bullet catches 4 casters

1 pc. grille cloth

1 pc. hardware cloth, '4" mesh

1 ball-bearing swivel



RADIO RECEIVERS

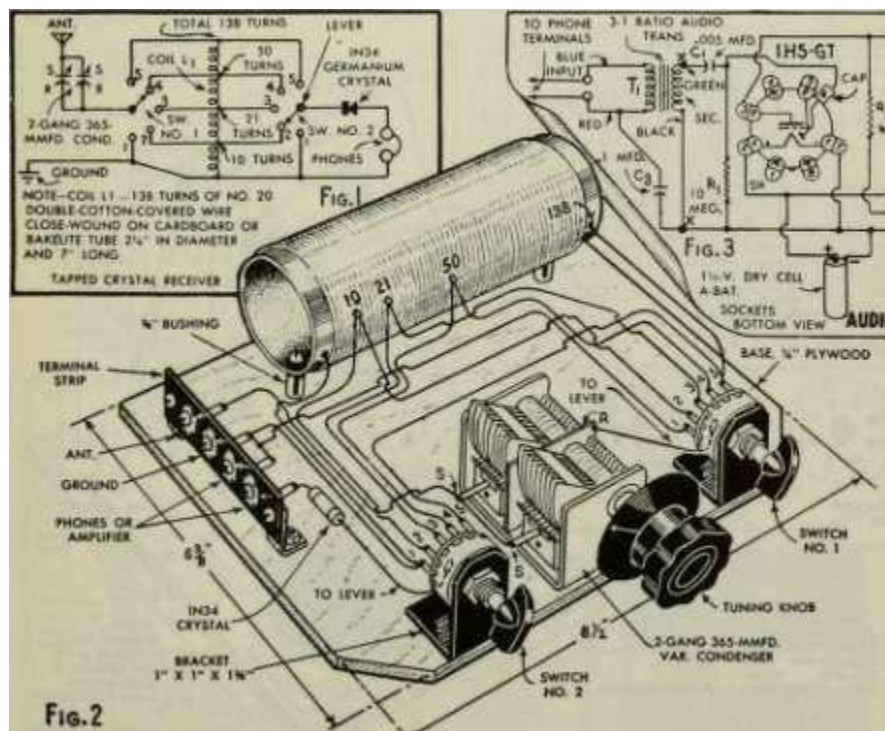
SINCE a crystal set is the simplest form of ^ radio receiver, it is the logical starting point for the student or junior experimenter. Unlike other types of receivers a crystal set uses

no batteries or power-line supply, therefore the sound that emerges from the headphones is derived entirely from radio energy picked up by the antenna. Use a long, high antenna and a ground connection to a cold-water pipe.

The selective tapped-coil crystal receiver illustrated in photos A and B employs adjustable loading in a simple tuning arrangement that is very effective when used with a good sensitive pair of headphones. A schematic circuit diagram and the coil-winding details appear in Fig. 1; pictorial wiring diagram in Fig. 2 shows all connections clearly.

The 2-gang variable-condenser stator plates (S), are connected in parallel; the rotor plates (R) are common with the frame. This lead goes to the lever of switch No. 1; the lever of switch No. 2 is connected to one side of the 1N34 germanium crystal, and the headphones are in series.

When winding the coil, place a toompick or



PHONES OR AMPLIFIER

TUNING KNOB

BRACKET 1" X 1" X 1H

2-GANG 365-MMFO. VAR. CONDENSER

BATTERY-OPERATED AMPLIFIER

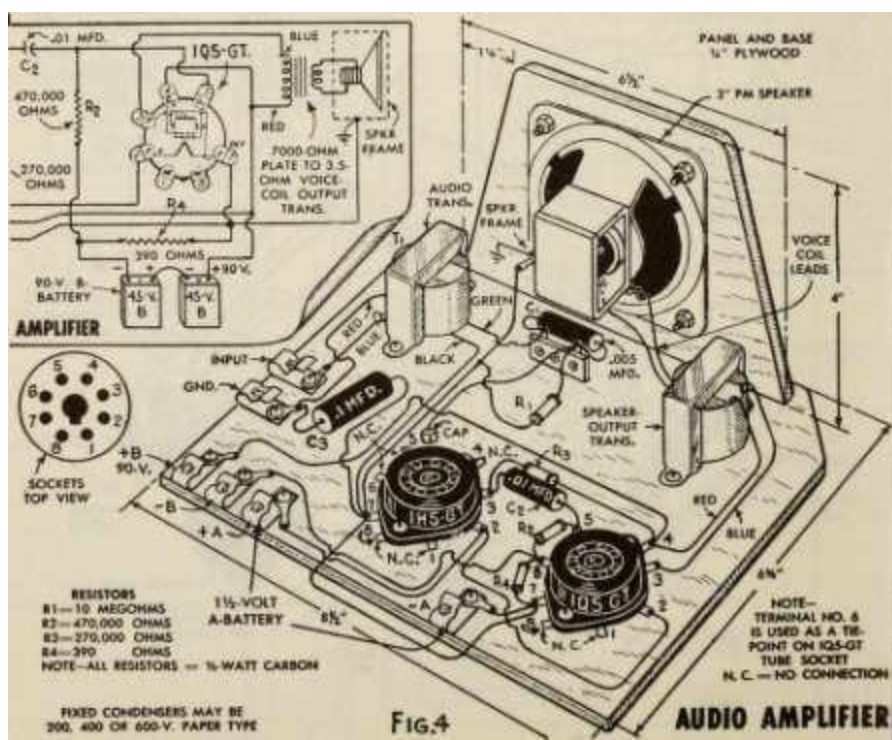
matchstick under the turns which are to be tapped; this aids in the removal of the insulation where the leads are to be soldered for switch points at 10, 21 and 50 turns. Later, if you wish to discard the headphones and use a small loudspeaker you can do so by

adding the 2-tube audio amplifier shown in photos C and D. The schematic circuit diagram is given in Fig. 3. All construction details for this amplifier unit are shown in the pictorial wiring diagram in Fig. 4. When connecting the units together, the grounded phone terminal on the crystal set connects to the ground clip on the audio amplifier; the insulated phone terminal on the crystal set is then connected to the input-terminal clip on the amplifier. The antenna and external ground leads on the crystal set remain the same. To turn the amplifier "on" and "off" either disconnect the positive (+) A-battery lead, or, insert a large s.p.s.t. toggle switch in this lead. The switch was omitted here to keep cost down to minimum. Two 45-volt B-bat-teries and a large IVa-volt dry cell A-battery provide power. No volume control is used.



PANEL AND BASE V." PLYWOOD

3" PM SPEAKER



RESISTORS

RJ = 10 MEGOHAS R2=470.000 OHAAS R3=270.000 OHMS R4=^390 OHAAS

NOTE-ALL RESISTORS

1%-VOLT A-BATTERY

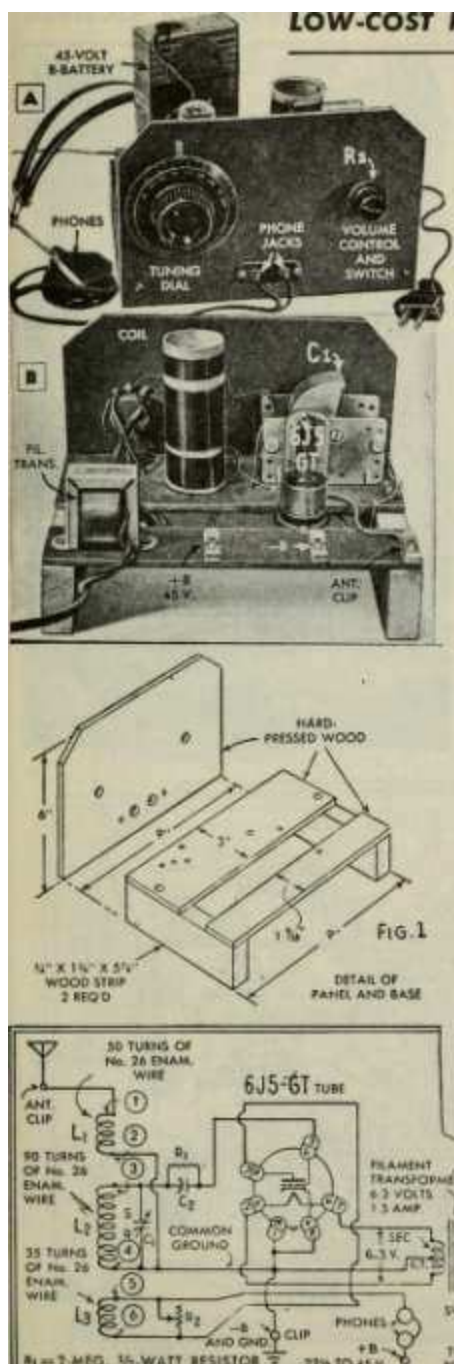
«i-WATT CARBON

nXED CONDENSERS MAY BE 200, 400 OR 600-V. PAPER TYPE

NOTE-TERMINAL NO. 6 IS USED AS A TIE-POINT ON ia5oT TUBE SOCKET N. C = NO CONNECTION

AUDIO AMPLIFIER

45-VOLT B-BAnERY



LOW-COST PROGRESSIVE RECEIVER

SPECIALLY planned for the beginner, ^ this 1-tube set is easy to build and simple to operate. It employs a type 6J5-GT tube and has sufficient sensitivity to give good headphone reception on standard broadcast stations up to about 400 miles at night. In addition to being an excellent 1-tube receiver in its own right, this little set can be easily converted to a 4-tube a.c. three-band receiver without wasting parts or even making any extensive changes in the layout, other than adding additional sockets, coils and parts. The 4-tube set which is described beginning on page 86 tunes the short-wave bands as well as the broadcast band and has sufficient volume to operate a magnetic speaker at good output. Each set is a complete construction article.

Various views of the first set are shown in photos A, B, C and D; the base and panel details are given in Fig. 1. This set is built up in a semibreadboard layout on a chassis made of

pressed wood, with two wooden strips which support the base. Note that the chassis is made in two pieces which permits the tube socket to be mounted without drilling large holes. The schematic circuit diagram appears in Fig. 2, and the simplified wiring diagram in Fig. 3.

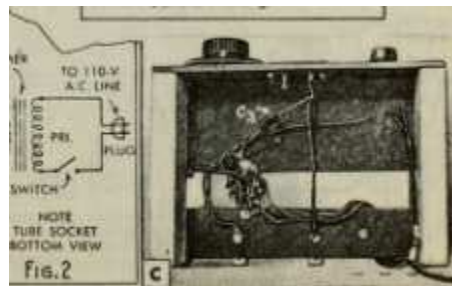
The coils are close-wound on the cardboard tube with the number of turns indicated. Punch holes as shown in Fig. 3 so that the start and finish ends of each coil may be threaded in and out to anchor the winding, leaving sufficient wire at each end for the circuit connections. The finished coil is mounted with ordinary china cement. An octal-type tube socket having a metal mounting plate is mounted across the space between the hard-pressed-wood strips. Care must be taken that all tube

PHONES-CLIP

+ B-22V4 TO 45 V. Ri=0-50,000-OHM VOLUME CONTROL ^03

AND GND R1 = '2-MEG. Vz-WATT RESISTOR~-

WITH SW'TCH



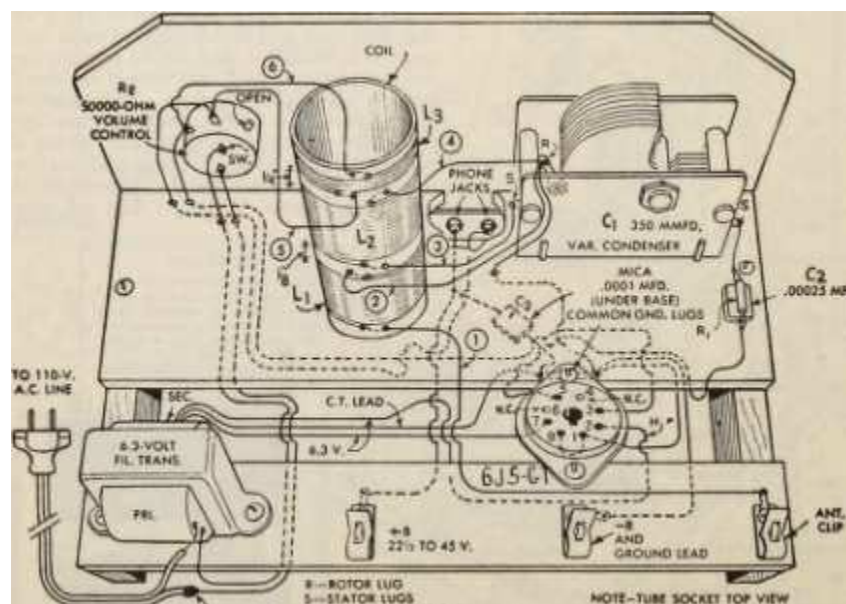
NOTE TUBE SOCKET BOTTOM VIEW

LOW-COST PROGRESSIVE RECEIVER

socket connections are made just as shown. A short metal strap is used to tie down the power cord running to the 6.3-volt filament transformer. Either a 22 V2 or 45-volt B-battery may be used to supply the plate voltage. The 6.3-volt filament transformer is an inexpensive 1.5-amp., or higher, type listed in all radio parts house catalogues. This is mounted on the rear strip which also carries the Fahnestock clips for the B-battery, ground and antenna leads. The "S" or stator connections on the variable condenser are common lugs on each side; the "R" or rotor lug is directly on the frame. This variable condenser can be any capacity between 350 mmfd. and 500 mmfd.

To test the set, be sure that your line supply is a.c, then plug the line cord into a wall socket; switch on the volume control and turn up this control until you hear a soft "plop" in the headphones. Next rotate tuning condenser Ci until you hear a whistle, indicating a station. Now back off the volume control until the station comes in clear and loud. An indoor antenna will receive strong local stations but best results will be obtained with a

good, high, outdoor antenna. The external ground connection at the negative-B clip can be made on a cold-water pipe or any convenient ground.



F«6.3

^

TAPED LEAD

R = ROTOR IUG

S^STATOR LUGS

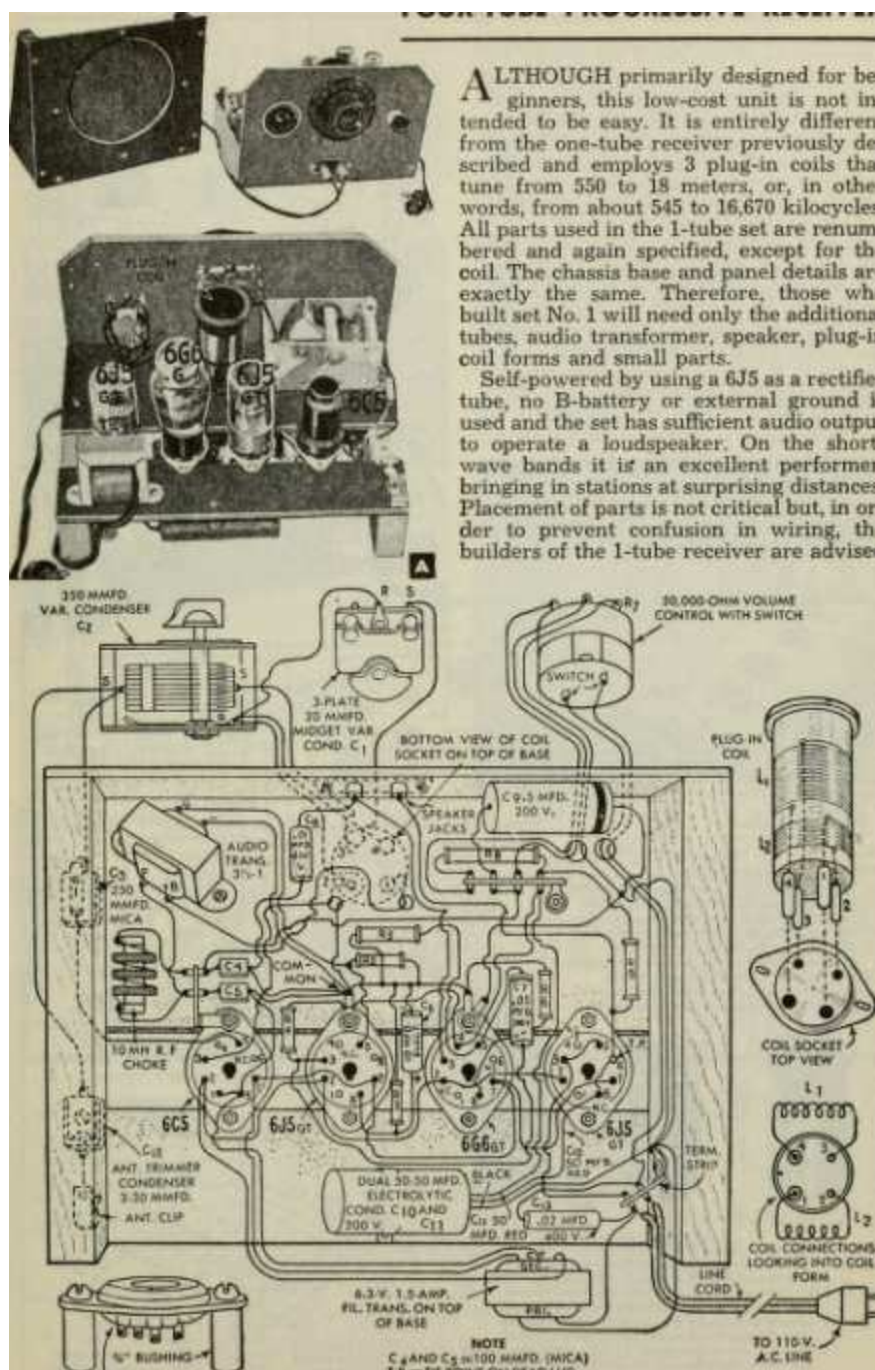
N.C =NO CONNECTION

NOTE-TUBE SOCKET TOP VIEW DONE D LINES INDICATt WIRING UNDER BASE

FOUR-TUBE PROGRESSIVE RECEIVER

ALTHOUGH primarily designed for beginners, this low-cost unit is not intended to be easy. It is entirely different from the one-tube receiver previously described and employs 3 plug-in coils that tune from 550 to 18 meters, or, in other words, from about 545 to 16,670 kilocycles. All parts used in the 1-tube set are renumbered and again specified, except for the coil. The chassis base and panel details are exactly the same. Therefore, those who built set No. 1 will need only the additional tubes, audio transformer, speaker, plug-in coil forms and small parts.

Self-powered by using a 6J5 as a rectifier tube, no B-battery or external ground is used and the set has sufficient audio output to operate a loudspeaker. On the shortwave bands it is an excellent performer, bringing in stations at surprising distances. Placement of parts is not critical but, in order to prevent confusion in wiring, the builders of the 1-tube receiver are advised



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4. PRONG COIL SOCKET ON TOP OF BASE

FIG. 1

NOTE

C₄ AND C₅ = 100 MMFD. (MICA) T.P. = TIE POINT ON DEAD LUG N.C. = NO CONNECTION C'6 = 25 V. ELECT. CONO.

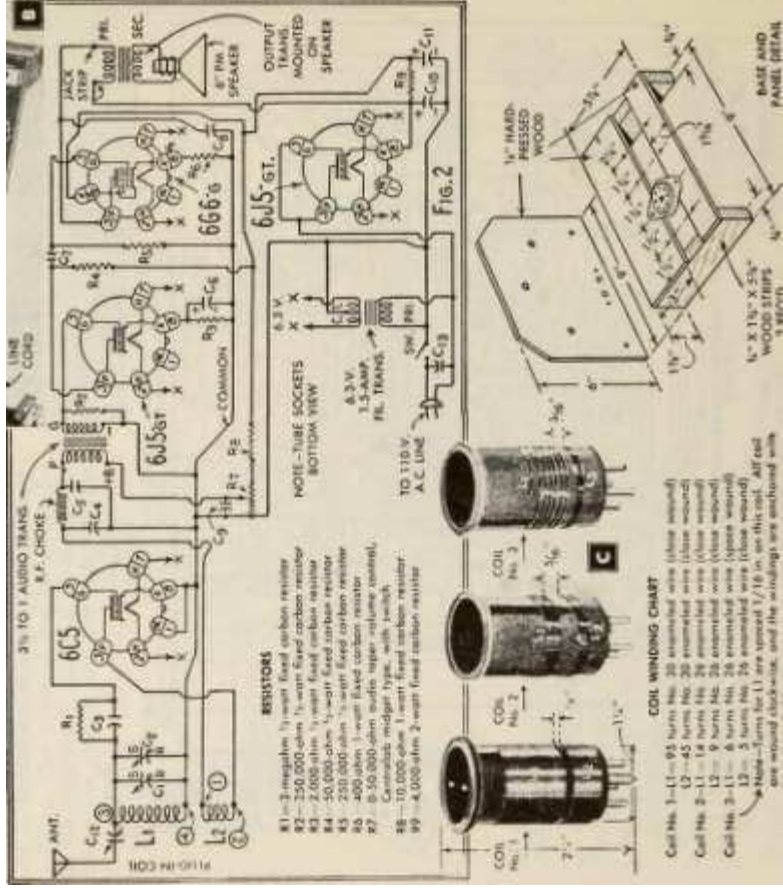
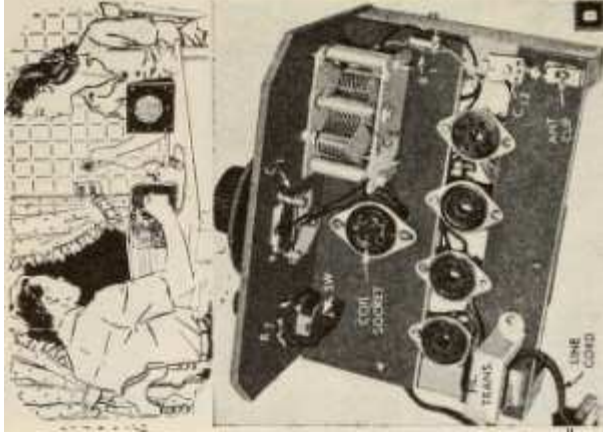
TO 110V. ^

FOUR-TUBE PROGRESSIVE RECEIVER

to remove all of the No. 1 set wiring and make a fresh start. The variable condenser, volume control and 6.3-volt filament transformer remain in the same positions.

The separate speaker unit is a 6-in. permanent-magnet type and a universal output transformer is mounted on the speaker. Voice coil connections are made on trans-former taps Nos. 1 and 4.

When wiring the set, check each lead with pictorial diagram, Fig. 1, and schematic circuit diagram, Fig. 2. The 3 coils are wound on standard 4-prong plug-in coil forms, and overlap to cover the shortwave radio bands. The hardboard speaker baffle is Vs in. by 8 in. For receiving local broadcasting stations a 10-ft. indoor antenna is best for selectivity; an outdoor antenna is best for distance. Condenser C2 is for the broadcast band; it also acts as a band-set condenser for short waves, and is set for the approximate frequency. All fine tuning is done with the small band-spread condenser C1.



coil WINDING CHART

Coil No. 1-11^95 turns No 30 enomeled wire (close wound)

1.2^45 turns No 30 enameled wire (close wound) Coil No. 2-11 U turns No 26 enameled wire (close wound)

12 = 9 turns No 26 enomeled wire (close wound) Coil No. 3-U- 6 turns No 26 enomeled wire (space wound)

12^5 turns No 26 enomeled wire (close wound) ► Note-Turns for 11 ore spaced 1 / 16 in. on this coll

ore wound clockwise, and the

Duco household

BASE AND PANEL DETAIL



PILOT LIGHT

UNIVERSAL

OUTPUT ; TRANS.

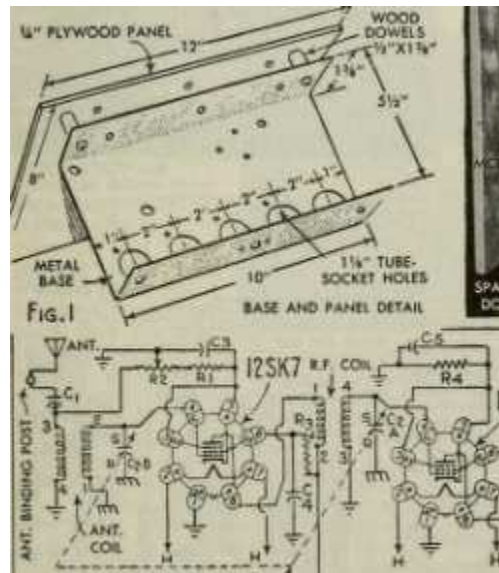
T.ft.F. DUAL-PURPOSE RECEIVER

ALTHOUGH simple enough for the be--^*- ginner, the unusual performance and flexibility of this 4-tube tuned-radio-frequency broadcast-band receiver will interest any experienced builder. The set includes a phono-input jack and may be used as an amplifier for a record player. Furthermore, it makes an excellent AM tuner for a public-address system, or for use with any large audio amplifier and separate speaker. When tested in Popular Mechanics radio laboratory, the fidelity and sensitivity were highly satisfactory considering the low cost and simplicity of design.

The most expensive parts are the tuning-dial assembly and the 6-in. PM speaker. An inexpensive 3 or 3^/^-in., 0-100 flat cir-

U" PLYWOOD PANEL

WOOD DOWELS



PHONO „^, _-, .

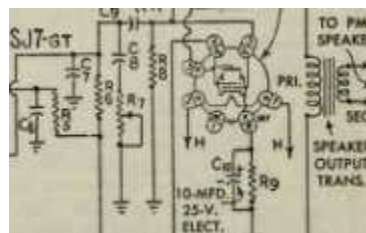
JACK-^^ I 50L6.GT

I2SJ7-GT rr

2-GANG 365-MMFD. COND

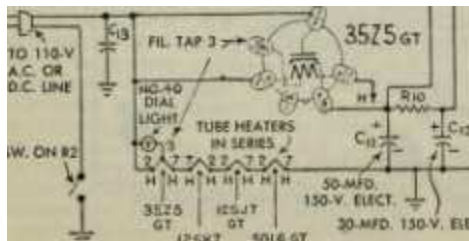
- = COMMON CIRCUIT GROUND = CHASSIS GROUND

SOCKETS BOTTOM VIEW



SW. ON R2

NOTE-SOCKETS BOHOM VIEW

C|₄

■ 1 —» ^ ^ N.N/N ^ ^ L

$$^{\pm} R_{ii} V^{\wedge}$$

FIG. 2

30-MFD. 150-V. ELECT.

RESISTORS

RI = 330-ohm, 1-watt carbon

R2 = ^25,000-ohm volume control oudio lopef, witi

R₃ .^22,000-ohm.'i-woltcarbon

R4 =47,000ohm.'i-woltcarbon

R5 --i2.2-megohm.'i-wottcarbon

R6 ii470,000-ohm,'i-woilcofbon

07 s^ 250,000-ohm polenliomeler for tone control

R8 =470.000ohm,',;-woilcarbon

R9 =150-ohm, 1-watt carbon

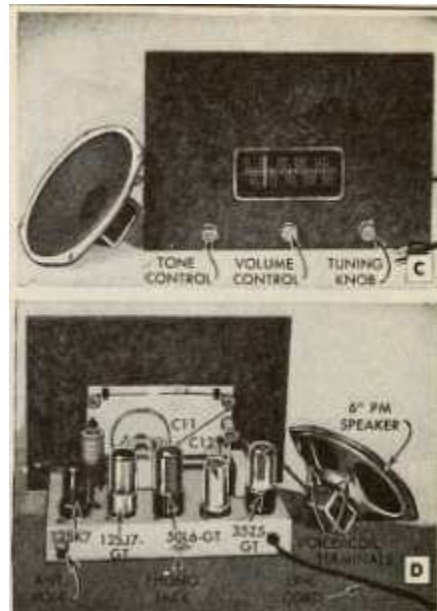
R10 ^ 12,000ohm, 1 -wall corbon

R11 = 220,000olim,' i-woll corbon

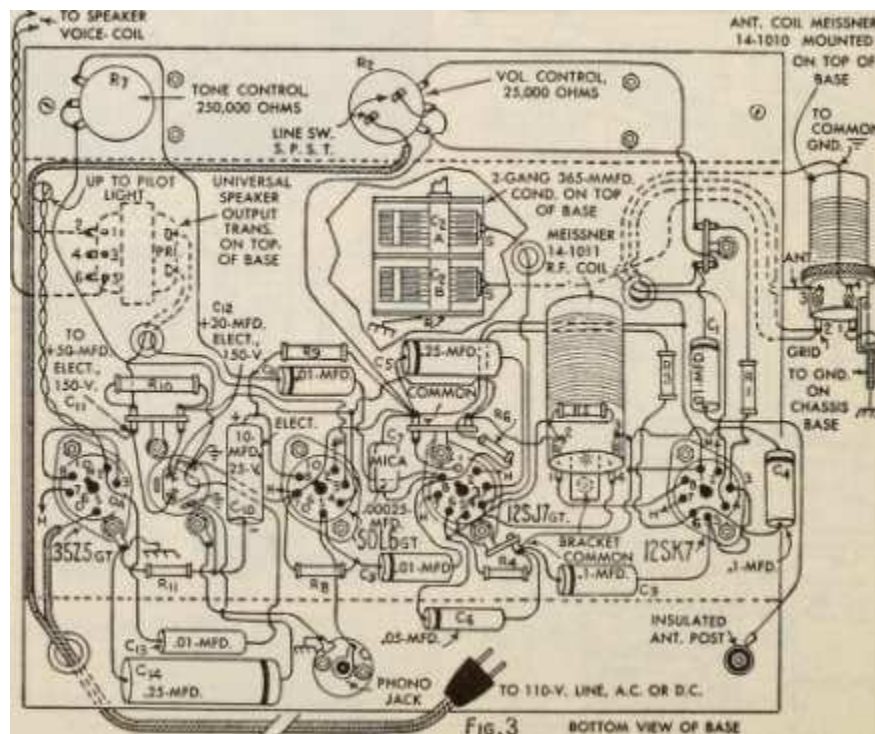
cular-type tuning dial may be substituted for the Croflex No. 231 tuning-dial assembly; both are listed in parts-house catalogues. The 6-in. PM (permanent magnet) speaker is a good size for this set; however, any 4-in. to 8-in. PM speaker that the builder has on hand may be used. The speaker should be mounted on a fairly large baffle in order to obtain good tonal quality. Speaker cabinets and enclosures are available in all standard sizes. Many students and experimenters prefer to construct their own. All parts specified and

used in the model are of high grade and were carefully selected to insure good service.

Those who wish to make their own chassis base will find the construction details in Fig. 1. This sheet-metal base may be bent to shape by clamping the metal sheet between two blocks of wood in a vise and using a wooden mallet. The standard-size chassis base supplied by parts houses is 1% X 5 X 9^2 in. These blank bases are available in either 20-ga. steel or in .005-in.-thick aluminum. The location of the parts on the chassis base is not critical but



ANT. COIL MEISSNER 14.1010 MOUNTED ON TOP OF BASE

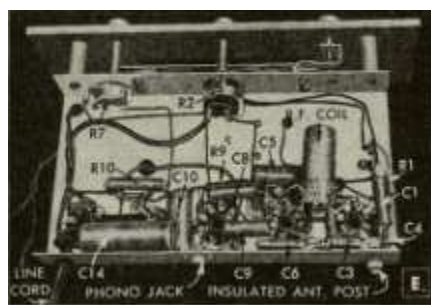


BOTTOM VIEW OF BASE

7.R.F. DUAL-PURPOSE RECEIVER

it is important that the tube sockets be mounted with the center keys in the position shown in the pictorial wiring diagram, Fig. 3. Photos A, B, C, D and E should be carefully studied before beginning construction. All parts are clearly identified in these photos and in the pictorial wiring diagram. Unmarked fixed condensers are 400 volt. Schematic circuit diagram, Fig. 2, carries the same coil-terminal key numbers and both diagrams should be checked as the wiring progresses. Use rosin-core wire solder and make certain that all soldered connections are neat and both mechanically and electrically strong. Please note that the common circuit grounds and the actual chassis grounds are clearly indicated and must be made as shown. No common circuit ground leads should touch the chassis. This entails a little extra wiring but it keeps the metal chassis from ever being "hot."

The antenna and R.F. coils are placed one below and the other on top of the chassis base and they are mounted at right angles to each other so that their corresponding fields will not cause oscillations. It will be noted that the antenna and the R.F. coil grid leads return to common ground while the variable-tuning condenser is to chassis ground; this also helps to prevent oscillations. If the Croflex tuning-dial assembly is not used, it will be necessary to mount the variable tuning condenser on the chassis so that the substituted circular dial will be centered on the front panel. In this case, the small tuning knob shown in the model will not be used. Therefore, the volume control can be shifted to its position to keep all the controls uniform on the y4-in. walnut-finished plywood front panel. The dial-light bracket and socket are supplied with the Croflex tuning-dial assembly; therefore, if this type of tuning dial is not used, it will be necessary to purchase a dial-light bracket with a screw-base socket and jewel and mount it on the plywood front panel at any convenient point. A good location would be at the upper left-hand corner when facing the panel. If the Croflex dial is used, the builder will find that complete assembly instructions come with it. The Meissner antenna and R.F. coils are provided with mounting brackets; when they are mount-



ed in the positions indicated, their terminal-numbering arrangement is as shown in the pictorial wiring diagram, Fig. 3. These standard coils are highly efficient, readily available, and should be used. The antenna coil is No. 14-1010 and the R.F. coil is No. 14-1011. The universal speaker-output transformer is a Stancor No. A-3856; the speaker voice-coil connections are made to secondary terminals 2 and 5 as the 50L6 tube should have a load impedance of about 2000 ohms.

If oscillations occur on the high end of the band when lining up the set after it is

completely wired, it may be necessary to remove the "gimmick," which is a single-turn wire connected to the primary and wound around the secondary of the antenna coil. Merely clip it off where it is connected to the primary. When aligning the set, adjust the trimmers on the variable tuning condenser C2-A and C2-B on a station at the high end of the broadcast band for maximum output. Then adjust them at the low end of the band for maximum output. Again return to the high end to see if maximum output is still obtainable. If not, reach a medium between the high and low ends. An indoor or outdoor antenna may be used depending upon location. Where there are a number of powerful broadcasting stations, a 15 or 20-ft. indoor antenna may be used. For distant reception, a good outdoor antenna will give the best results. No external ground wire should be used on this a.c.-d.c. receiver. If the set is to be used as a tuner in connection with a large amplifier and speaker, turn the set volume control to maximum to keep hum level at the lowest possible point. Volume is then controlled at the larger amplifier in the usual manner. Also when you use this receiver as a tuner in connection with a larger amplifier and speaker, remove the set speaker and replace it with a 5-ohm, 5 or 10-watt wire-wound resistor. Use a shielded connecting lead with a phono plug and ground the shield on the plug cap. Connect this lead to the phono jack on the set and to the input of the large amplifier. Adjust the set volume control and the amplifier volume control for the desired volume and lowest possible hum level.



' I BATTERY - KNE ^

, ANGLE SWITCH No. 1 /

^, ^l'^?u^, ..., V'VENTILATING

2REQD. $V_{visg} = ^$

5 No. 2 FLASHLIGHT CELLS IN SERIES

THREE-WAY PORTABLE SUPER

"C^ULL 5-tube performance fe obtained -*■ with this versatile 4-tube portable receiver



point. The Vio-in. sheet-aluminum chassis base is detailed in Fig. 1. This base is quite simple and may be formed over a block of wood clamped in a vise. The brackets are cut from the same material. Photos A, B, C, D and E show various views of the completed set.

Wire the filament circuit and filament supply first, and keep all wiring short and as close to the chassis as possible. Leave the tubular paper condensers and resistors

2GANG ^.4R COND. RCC

MODEL 225' SEE TEXT)'

IRS BLUE T^,GREEN |T4 BLUE _ J^j ^reen 'S5



osc. coil meissner

14-1040 .

SELENIUM C22C23C2-1 - RECT. -J, -J, -J, -J.

,^ 1 IOV. A.C. OR D.C.

Fig. 3

TUBE HEATERS IN SERIES -I

<^2yA 1T4 1R5 1S5 7 aKi W> ^A

THREE-WAY PORTABLE SUPER

until all other wiring is completed. The schematic circuit diagram appears in Fig. 3. Use No. 20 or smaller hookup wire and rosin-core wire solder for the circuit. As the terminals on the tube sockets are small and may require several connections, care must be taken in soldering. Be careful that excess solder does not run down the terminals, touch another terminal or the chassis to cause a short. Always connect the outside foil of paper-type condensers to common ground when they are used as screen by-pass or AVC filter condensers; for fixed condenser values see Fig. 4. The Crowe dial comes with complete instructions for stringing the dial and cutting the panel hole in the cabinet. Complete details for the cabinet and A-battery case are given in Fig. 2. The cabinet is constructed of Vi-in. plywood and strips of V2 by 1/2-in. pine. All joints are glued and nailed with brads. The cabinet is given a thin coat of shellac, then stained any desired color. The final finish coat is a flat lacquer which is later .polished with a heavy coating of paste floor wax. The handle is a dime-store chrome drawer pull. The A-battery case must slide easily in and out of the cabinet to prevent injury to the dial mechanism. Five iy2-volt No. 2 flashlight A-batteries are connected in series either by directly soldered connections, or phosphor-bronze spring clips, if preferred. To change the A-batteries, remove the two control knobs on the front and the two small angle brackets at the back of the chassis and pull the receiver partially out of the cabinet. Have the A-battery leads long enough to remove the case and be careful that they do not short on the chassis or any other wires or terminals in the set. Snap-clip leads are used on the 67y2-volt B-battery. All tubes must be in their sockets when this set is operated on the 110-volt line. The A and B-batteries need not be in place but tape their leads to prevent shorts. To place the set in operation, throw switch No. 1 to the position for the type of power used and then turn on switch No. 2. The set will begin to play as soon as a station is tuned in. Very little adjustment of the i.f. transformers is required as they are pre-tuned at the factory. Tune the set to a station at about 600 kc. and adjust the i.f. trimmer condensers for maximum volume. Loosen the dial drum on the variable-condenser shaft and move the dial pointer so that it reads the frequency of the station tuned in. Now tighten the dial drum and tune in a station at about 1400 kc. and check the frequency of the station on the dial. If it is not correct, adjust trimmer C4 and the 19-plate

CONDENSERS (Fig. 4)

1—Two-gang variable condenser with cut-plate oscillator section Radio Condenser Corporation model 225, type CN825171 CI, C2 and trimmers C3, C4

7—.05-mfd. 400-v. paper-type condensers C5, C10, C13, C14, C15, C16 and C25

1—50-mmfd. mica-type condenser C6

2—100mmfd. mica-type condensers C7 and C8

2—.01-mfd. 400-v. paper-type condensers C9 and

• C11

1—.005-mfd. 400-v. paper-type condenser C12

1—Mollory-type FP302 electrolytic condenser unit: 15-15 mfd. 150-v. C17 and C18; 1000-mfd. 2-v. C19

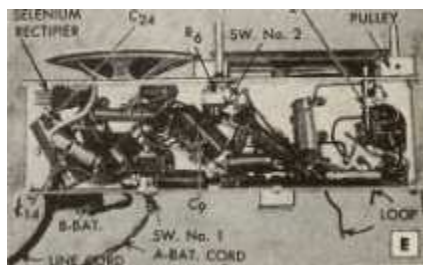
1—50-mfd. 25-v. electrolytic condenser C20

1—Mallory-type FP309 electrolytic condenser unit: 100-mfd. 25-v. C21; 50-mfd. 150-v. C22; 30-mfd. 150 V. C23. Note—both Mallory units have 3 sections

1—50-mfd. 150-v. electrolytic condenser C24

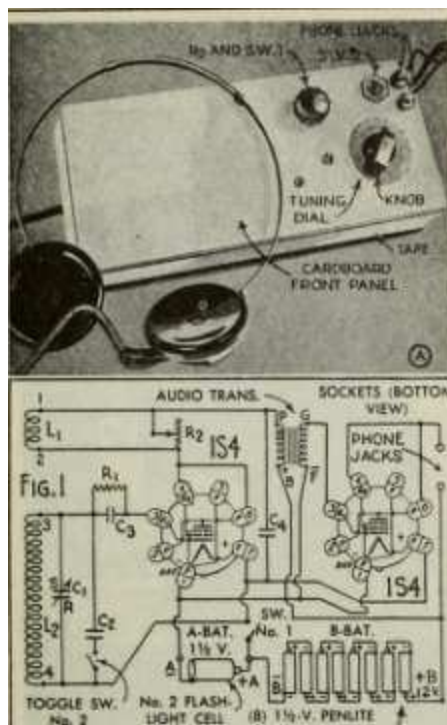
OSC. COIL L, DIAL CORD

PULLEY



170.7 to 8.7-mmfd. oscillator section C2, until the reading is correct. The oscillator coil has a powdered iron-core slug that will now have to be adjusted with a small screwdriver to secure the proper dial readings in the middle of the dial. These last adjustments may have to be repeated several times to insure proper tracking over the entire dial. Finally adjust trimmer condenser C3 on section CI of the 2-gang condenser for maximum volume; the capacity of the 27-plate section CI is 431 to 11 mmfd. Terminals A and G on the loop antenna are for external antenna and ground connections if required in remote locations. Two short machine screws are used to mount the loop on the rear chassis bracket. This makes an excellent three-way superheterodyne portable receiver for the experienced builder, and it is ideal for advanced radio classes working under supervision of an instructor. If parts specified are used, and care is taken in construction and wiring, the receiver will be highly satisfactory.

TWO-TUBE "POCKETTE" PORTABLE



'■) i

(8) I'/j-V. PENIITE 4

CELLS IN SERIES—^

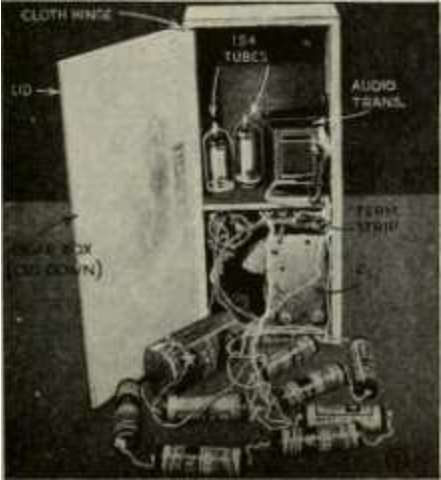
R1 =2 meg. Vi watt resistor R2 = 0-10,000-ohm vol. control CI =350 mmfd. vor. condenser C2, C3 and C4=.00025 mfd. tnica or paper type

LI = 15 turns No. 24 d.e.e.

L2 = 20 turns No. 24 d.e.c.

wire Note-Either No. 22, 24 or

26 wire may be used



A LTHOUGH slightly larger than some ■^*- of the new subminiature-tube pocket

receivers, this two-tube personal-type receiver is still small enough to slip into your coat pocket, with just enough extending out the top for tuning purposes. Using a built-in loop antenna and operating without external connections this pocket set brings in local broadcasting stations with excellent volume and clarity for a small portable 2-tube receiver. It also includes a high-low switch and fixed-condenser tuning arrangement with the result that it tunes all of the broadcast band with an additional range on both ends of the dial.

Designed for the student experimenter and built from odds and ends of spare parts, it is easy to duplicate. All parts specified are to be found in any radio catalogue. The variable condenser CI is a midget type that can be any capacity from 350 to 500 mmfd. Despite its small size this set employs a tiny chassis base or tube-mounting panel of hard-pressed wood. This helps to keep the leads short and supports the tube sockets firmly. The schematic circuit diagram, Fig. 1, and simplified wiring diagram, Fig. 2, show all construction details. The builder should check each wiring detail with both diagrams in order to avoid errors.

Two type 1S4 miniature tubes are employed in a standard regenerative circuit. It consists of a regenerative detector transformer-coupled to a single audio output stage. The outstanding feature of the "pockette" set is the coil, which consists of two windings made directly on the outside of the wooden case. This coil provides a loop antenna for reception and, like all loops, it is directional. Although No. 22 cotton-covered wire is preferred, any small wire such as No. 24 or No. 26 may be used. In this model No. 24 d.c.c. wire was used for the coil and practically all of the circuit connections. Please note that the A and B-battery leads are soldered directly to the positive and negative ends of the flashlight cells. Battery clip arrangements are not advised as they usually fail to make good mechanical and electrical contacts. Eight "penlite" cells connected in series provide 12 volts for the B supply. The A-battery consists of a single standard-size (No. 2) flashlight cell. In this compact pocket set no attempt is made to cable the battery leads; all other circuit leads should be kept as short as possible.

Photos A, B and C clearly show how the

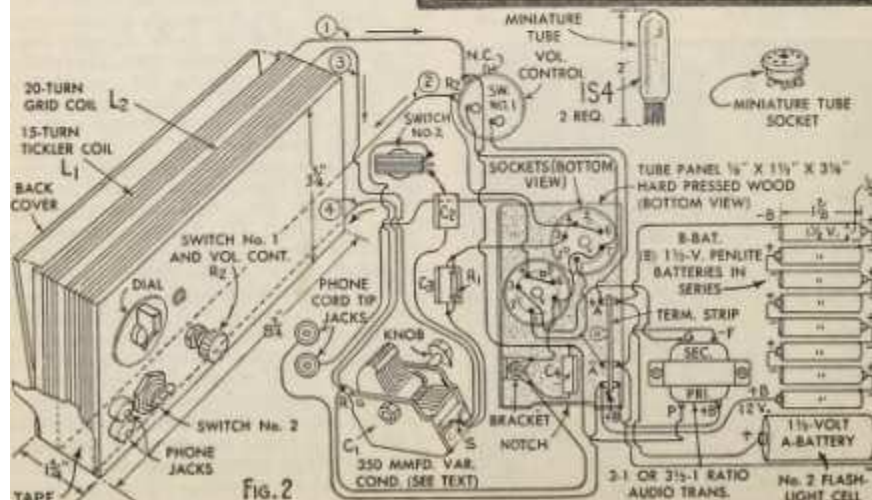
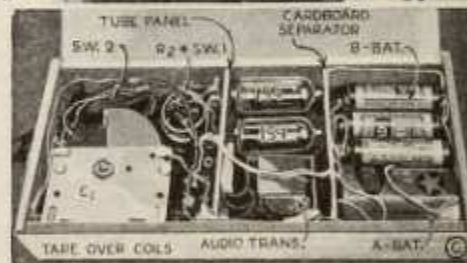
TWO-TUBE "POCKETTE" PORTABLE

various controls and parts are arranged. The tube-mounting panel is supported on the back of the cardboard front panel by means of a small angle bracket and a short machine screw so that the bottoms of the miniature tube sockets will just clear the combination midget volume control and switch No. 1. The audio transformer should be an open-frame single-plate to single-grid midget type. This is mounted by means of a short 6-32 machine screw, the mounting lug extending through the notch cut in the end of the tube-socket panel. The case is made by cutting down a cigar box to the dimensions given in Fig. 2. The depth may be increased slightly depending upon the size of your parts. Do not change the width or length dimensions or the loop antenna coil will not function properly with the

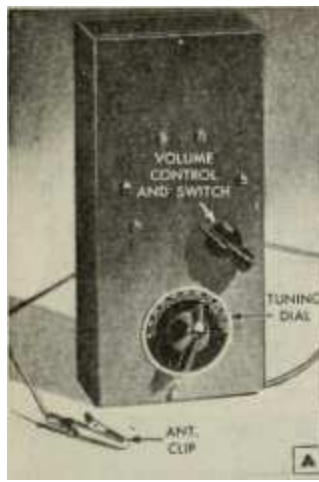
midget variable condenser specified. Both coils are close-wound in the same clockwise direction, and are spaced $\frac{1}{8}$ in. apart. When the set is completed and working, the coils should be completely covered with adhesive tape; the entire cabinet may be covered with black oilcloth or other material if desired. In doing this be careful no moisture reaches the coils; this is important. With switch No. 2 thrown to the position that adds fixed condenser C₂ to the circuit the set tunes from approximately 530 kc. to about 900 kc. With C₂ switched out of the circuit the receiver tunes from 900 kc. to approximately 1600 kc. For distant stations an external antenna wire can be attached to stator (S) on condenser C₁.

Various controls and parts are arranged. The tube-mounting panel is supported on the back of the cardboard front panel by means of a small angle bracket and a short machine screw so that the bottoms of the miniature tube sockets will just clear the combination midget volume control and switch No. 1. The audio transformer should be an open-frame single-plate to single-grid midget type. This is mounted by means of a short 6-32 machine screw, the mounting lug extending through the notch cut in the end of the tube-socket panel. The case is made by cutting down a cigar box to the dimensions given in Fig. 2. The depth may be increased slightly depending upon the size of your parts. Do not change the width or length dimensions or the loop antenna coil will not function properly with the midget variable condenser specified. Both coils are close-wound in the same clockwise direction, and are spaced $\frac{1}{8}$ in. apart.

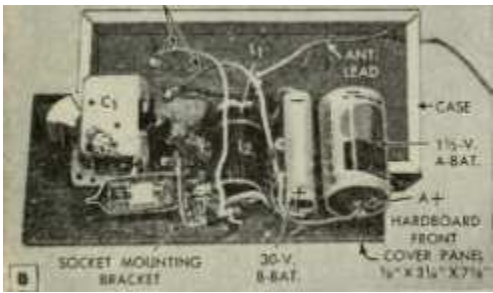
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ONE-TUBE EMERGENCY RECEIVER



PHONE LEADS



ONLY ONE miniature tube is used in this "handi- talkie" type battery-operated receiver. It is ideal for use during power-line failures, blackouts, hurricanes and similar emergencies. Small enough to slip into a coat pocket, it will bring in local broadcasting stations with only an emergency antenna. The short antenna lead shown in photo A terminates in a clip that can be clipped to the finger stop on a dial telephone, a metal lamp base, as shown in photo C, a metal window screen or any other metallic object in the home. Outdoors, any metal railing, wire fence or other large piece of metal provides an emergency antenna. All parts are inexpensive standard materials. The case is made of Vi-in. pine or plywood and the top and bottom covers are made of Vs-in. hardboard. The over-all dimensions of the case are given in photo D. Most of the parts are mounted directly on the hardboard front panel as shown in photos B and E. The single earphone, which is from a 2000-ohm headset, should be a type that has outside terminals. It is mounted on the back panel by means of its terminal screws.

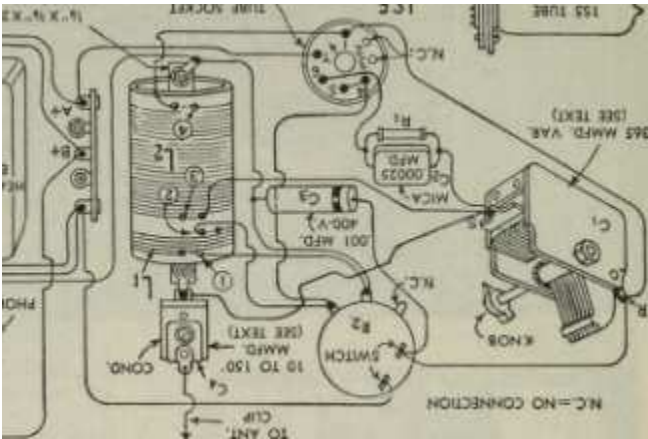
The coil for the set is hand-wound on a cardboard case from a "C"-size flashlight cell, as in Fig. 3. Coils LI and L2 are both close-wound in the same clockwise direction as shown in pictorial diagram Fig. 1 and diagram Fig. 3. Two small holes are punched in the cardboard form to anchor the wire at the start and finish end of each coil. The schematic

circuit diagram appears in Fig. 2;

COVER PANEL ! No. 18 or 20 flexible insulated hook-

Ve"X3'4"X7V8"

> NO CONNECTION = N.C.

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V. phone " : . - _ √ - , - / , , ,

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BRACKET ~ FOR TUBE SOCKET %" WIDE VA" HIGH



B-BAT. 30-V.

HEARING-AID BATTERY

vvI

FLASHLIGHT BATTERY

ISI Fig

TUBE SOCKET

MINIATURE BOTTOM VIEW

TUBE

'/»"XH"X2'i" HARDBOARD STRIP

RESISTORS R1=2 MEGOHMS 'j-WATT CARBON R2 = 0-5000OHM VOLUME CONTROL WITH S.P.S.T. SWITCH

ONE-TUBE EMERGENCY RECEIVER

up wire is used for all connections except those to the coil, which are made with the coil wire ends. Be careful when wiring the terminals of the tube socket as a wrong connection here can result in a blown-out tube. The rotor plates of condenser C1 are common with the condenser frame; this is the terminal R. Power for the set is provided by one No. 2 standard-size flashlight cell and a 30-volt hearing-aid battery. Battery drain of the miniature 1S5 tube is very low. Test the set first with a standard outdoor antenna or a long indoor wire. Assemble it in the case temporarily; open the setscrew on the small trimmer condenser C4 as far as it will go. The on-off switch is combined with the volume control. Turn this control "full on" and rotate the variable condenser until you hear a whistle indicating a station. Now back off the volume control very slowly until the whistle disappears and the station comes in clear. After the set is in working order with the standard antenna, connect it to any convenient emergency antenna such as the lamp base, or the stop on a dial phone, and adjust condenser C4 to be as far closed as possible without eliminating the oscillation whistle at the low (550 kc.) end of the band. The case cover is now closed with two small brads. This emergency set is designed for local stations; it is not intended for distant reception. Case may be stained and varnished if desired.



ANT. LEAD

NOTE-R ROTOR ,

(COMMON WITH COND. [i j

30 TURNS No. 30 EN AM. WIRE

GRID COIL jT 112 TURNS

No. 30 ENAM. WIRE

SWITCH ON VOL.' CONTROL



A-A-»-lVb-V. B-

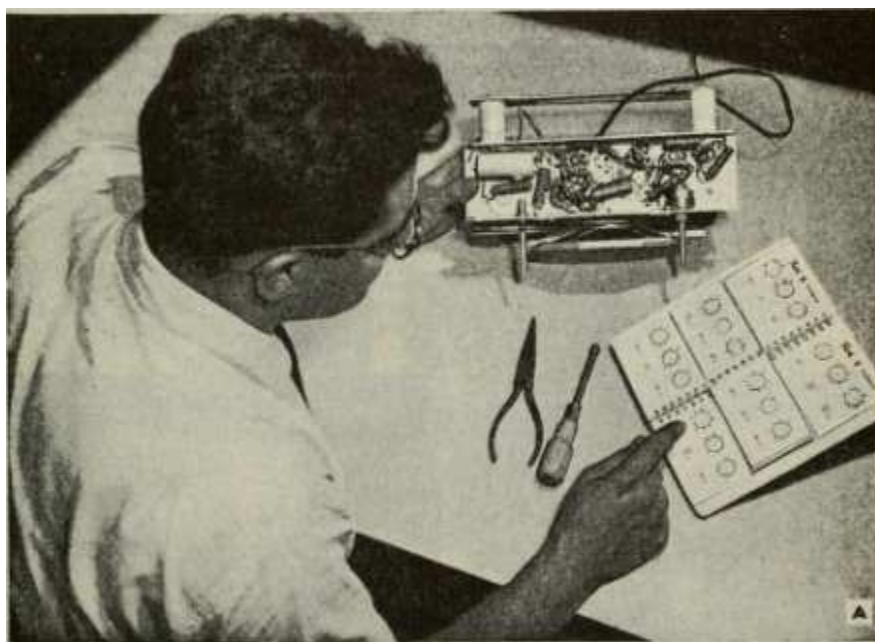
COIL WOUND I B 4-30-7 ON "C" SIZE - FLASHLIGHT |

RADIO SERVICING

RADIO SERVICING is a profitable occupation and many experimenters become interested in its possibilities through working with their receivers and by building their own radio and electronic equipment. They may then take a good training course and attain real professional standing in their communities. The experimenter soon learns that what he saw when he first looked at the underside of a radio-receiver chassis was not just a jumble of strange-looking parts, but a well-planned electrical device which works according to known electrical rules. The commonly used radio parts illustrated in this book will become very familiar as you find them in radio receivers, amplifiers, television receivers and even tiny midget sets. They may vary in size, type and value, but they all belong to the same group.

Basic Radio and Electronic Parts

The main, or basic, parts of any radio receiver or electronic device are the coils, tubes, condensers and resistors. Any of these basic parts can become defective. Regardless of type, a radio coil is a continuous winding through which an electrical current flows. If the wire should break due to strain, corrosion or poorly soldered connections, current



can no longer flow through the coil and the set is dead. A simple continuity test with a meter or a flashlight bulb in series with a dry-cell battery will indicate the "open" circuit very quickly. If the break is at a terminal it is a simple matter to resolder the connection; however, if it is under several layers of wire and cannot be seen, the obvious remedy in most cases is a replacement coil. Short circuits occur when insulation on the wires breaks down and there is contact between the bare copper wires, or layers of turns on the coil.

This makes it possible for current to flow through the break, taking a "short cut" to the other wire or adjacent layer instead of following the intended number of turns of wire. Thus this short circuit changes the property of the coil so that the current is not flowing at its rated intensity. Moisture and changes in the spacing of the turns also change the electrical characteristics of coils and interfere with operation. Radio receiver troubles follow a fairly well-defined trend; your set either does not play, or it operates incorrectly. Faulty operation includes hum, distortion, oscillation.

SERVICE HINTS FOR STUDENT EXPERIMENTERS

intermittent operation and weak signals. If the set is dead, first check to see if the glass tubes all light, and all tubes are tight in sockets; make certain the antenna connections are not defective. See that the speaker is plugged in, and that all tube caps are in position. If there is any evidence of heating, such as smoke coming from the chassis, disconnect the set immediately.

Most experimenters learn to make these checks very quickly. If none of these checks indicates the trouble, the next step is to check the tubes and make a complete circuit test, working back from the power tube to the antenna input of the set. The experienced worker will quickly isolate the defective stage in most cases by this method. Do not guess at tube-base connections, always keep a receiving-tube manual on the workbench. A handy reference booklet of tube-base diagrams is shown in photo A; this is known as the "Triple Pindex." It permits the worker to instantly locate and simultaneously study any three tube-base diagrams out of over 475 types. After locating the dead stage, check connections and parts for continuity with an ohmmeter. If new parts are required they should be of good quality and exactly as specified in the service manual for that particular receiver. After the repair is made, operate the set for an hour or so to be sure that no further trouble develops.

Trained service men agree that an im-

properly playing receiver often presents a more difficult problem than one that is dead. There is no definite or easy method that will show up the defect quickly. However, most well-trained service men and many experienced radio students locate such troubles in a surprisingly short time. They know just what parts in a circuit could cause the trouble indicated by the symptoms. If the set hums, the first thing to do is to check the filter system, especially electrolytic filter condensers. If a high-gain audio amplifier is used, it is a good idea to try new tubes even though the ones in the set check good in the tube tester. Cathode-to-heater leakage may not show up in the tester. If there is distortion in the set at a low setting of the volume control, excessive bias on some tube is indicated. If distortion occurs at a high setting, the bias on some tube is too low. In the service manual of the set, the schematic circuit diagram will show what could cause this, so these points are immediately checked.

Intermittent reception presents a problem for most service men. Poor contact between fixed condenser lugs and the foil in a coupling condenser is a common cause of this trouble, and the repair of course is a new condenser of the same capacity and voltage rating. Poor chassis ground connections, loose soldered connections, defective tubes and resistors are other common causes of intermittent reception.

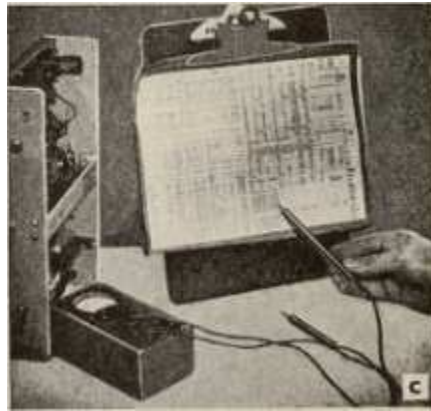


Photo B —Miniature tube test-point adapter permits tube-base tests to be made on tube side of radio chassis. Place adapter in tube socket and insert tube in top; under-chassis wiring and components need not be disturbed.

Photo C —A spring clip board will be found very handy for holding tube charts or diagrams. An improvised support may be attached to the back.

SERVICE HINTS FOR STUDENT EXPERIMENTERS

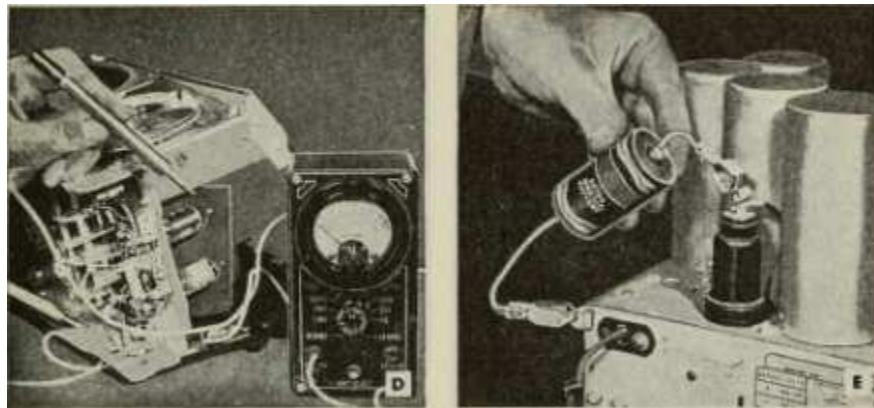


Photo D —Supporting the radio chassis while it is under test on the workbench presents a common problem, especially when the set employs fragile miniature-type tubes that must be protected. Ordinary rubber door stops, or a piece of hardboard can be used as shown. Adjustable chassis cradles are also available for this purpose.

Photo E —A single 1¹/₂-volt flashlight cell may be used in the manner illustrated to aid in detecting the dead stage in a radio receiver. When the battery is clipped to the chassis and the positive terminal used in a make-and-break contact at the tube grid, a clicking noise should be heard in the speaker if the stages ahead of the tube are working. Clicking is caused by the change in grid voltage due to the temporary battery hookup.

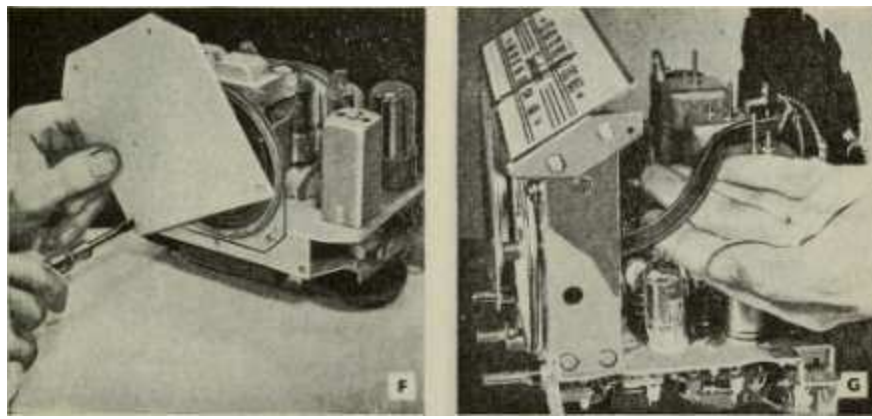


Photo F —When working on small table-model receivers that have the speaker mounted on the chassis, there is always danger of damaging the speaker cone when lifting the chassis, or by striking the cone with a tool. A temporary protective cardboard cover solves the problem as illustrated. Cut it large enough to cover the metal speaker frame and punch holes in the corners so that it can be fastened to the frame.

Photo G —When changing tubes or making repairs in FM receivers, or any high-frequency type of receiver which employs a flat two-conductor lead that is connected from the antenna terminals to the antenna coil, always check the position of this lead-in cable before moving it. Changing the position of this cable may result in unsatisfactory operation; if you move it, always see that it is put back in the original position.

SERVICE HINTS FOR STUDENT EXPERIMENTERS

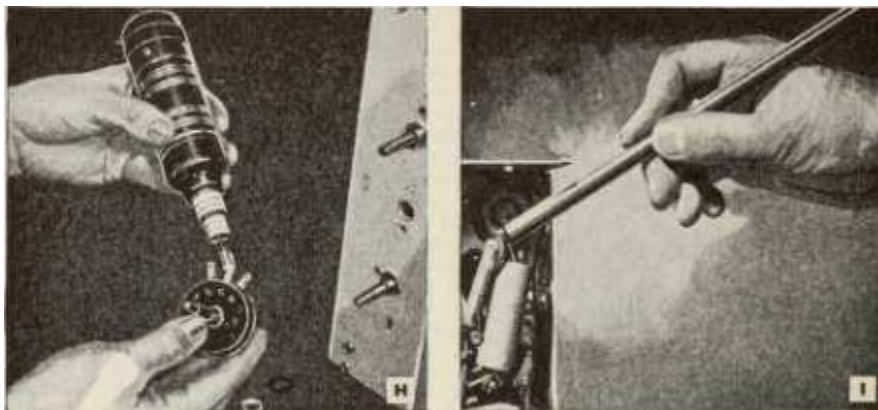


Photo H —A small electrically operated hand grinder makes a good tool for the radio workbench. It may be used to remove old solder from holes in the lugs of a volume control as illustrated. It is also useful for cleaning wires and terminals preparatory to soldering when replacing a radio part in a chassis. When soldered ground connections are made on chassis bases, the grinder may be used to clean a spot for a good connection.

Photo I —Many times a poorly soldered joint, or a defective resistor or condenser may be located by probing gently around such parts. A good tool for this purpose is a piece of Bakelite or fiber rod, or an insulated aligning tool as illustrated. A piece of wooden dowel rod is also useful for this purpose. Do not use a screwdriver for probing.

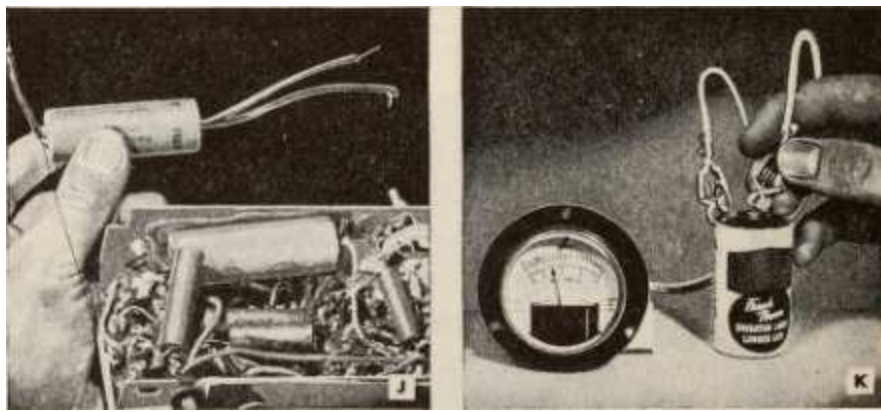


Photo J—Small a.c.-d.c. radios usually employ a double filter condenser of around 20-20 mfd. These filter condensers become inoperative in time due to deterioration, with the result that the set loses volume and becomes noisy. If the tubes in the set test satisfactorily it is well worth while to replace this dual-type filter condenser. Before removing it carefully note the polarity markings on the original. The common negative, usually the black lead, will go to the low voltage side of the circuit, while the positive is the high voltage side. The replacement condenser must have the same capacity and voltage ratings.

Photo K —New multirange d.c. voltmeters can be safely checked for accuracy with a fresh flashlight battery for 1 1/2 volts. This serves to show polarity of test leads and meter before connecting it to a higher voltage which might damage the meter.

SERVICE HINTS FOR STUDENT EXPERIMENTERS

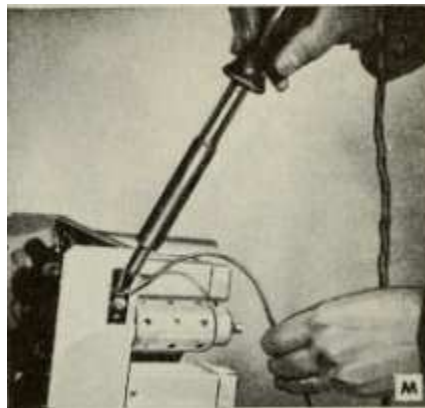


Photo L —Small glow lamps rated at V27, or 60 watt may be used to advantage on a radio test board, or in any double wall outlet as illustrated. Available in dime stores, these tiny glow lamps will give an indication or warning that the outlet is energized and may prevent equipment from being left connected when not required. They are also useful as indicating lamps in testing various stages in amateur transmitters.

Photo M —Loose antenna and ground connections are always a source of noise in a radio receiver. If the threads are stripped on a screw terminal in the antenna-ground terminal strip on the rear of the chassis, solder a short length of wire directly to the defective terminal as shown and connect the lead to the short wire.

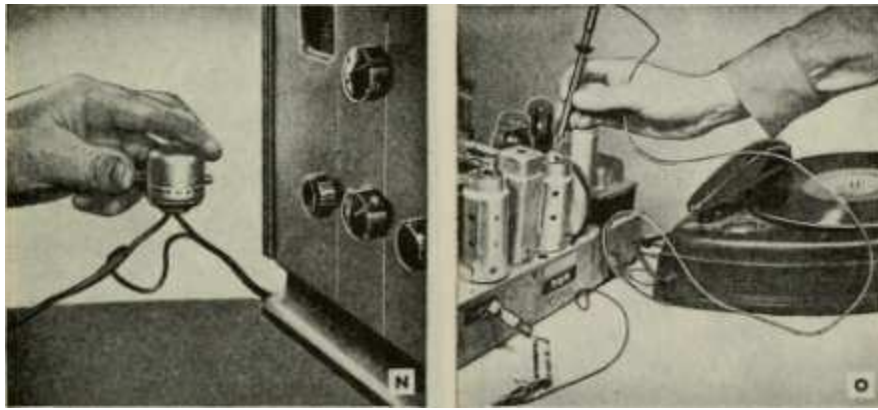


Photo N — On set. .;.^.^ :.l o.. itch and volume control are combined an external snap-switch inserted in one side of the set power cord as illustrated saves waiting for the set to warm up when left on a certain station at the desired volume. With such an arrangement wear on the volume control is greatly reduced. This idea is also convenient when a replacement switch control is not available.

Photo O —A record player may be connected through test leads as shown to the audio section of a receiver to test for certain defects. Note that one lead from the pickup is connected through a .05 mfd. paper condenser to the radio chassis, while the other lead is attached to a probe and touched to the grid of a tube that is used as a combined detector and amplifier. Other checking points are possible, depending upon the circuit.

SERVICE HINTS FOR STUDENT EXPERIMENTERS

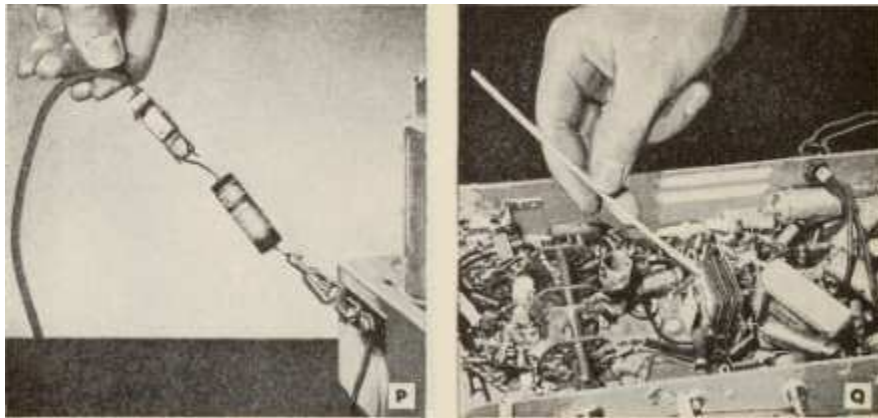


Photo P —Lack of sensitivity is sometimes due to an antenna that is excessively long. This condition can be checked by placing a .005 mfd. paper-type fixed condenser in series with the antenna lead-in as shown. If selectivity is improved the condenser may be left in position, or the antenna shortened. The total length of the antenna includes lead-jn. In localities having a number of stations, good selectivity is important.

Photo Q —Selenium rectifiers of the type indicated are used in many modern radios in place of rectifier tubes. The active material on the plates of such rectifiers may be damaged by overheating. Therefore, other equipment should be kept in the clear. Openings in the chassis located directly above this rectifier should be kept free for ventilation.

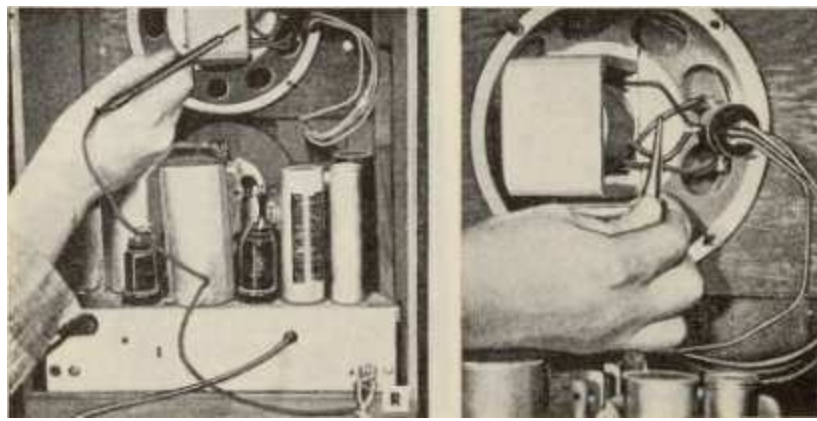


Photo R —Reception may sometimes be improved and hum reduced by grounding the loudspeaker frame to the chassis of the set. This may be checked by connecting a test lead to the chassis with a clip and touching the test prod to the speaker case.

Photo S —In certain dynamic speakers a hum-reducing coil is added on the form containing the field-coil winding. This hum-bucking coil is made up of a number of turns of wire and arranged to pick up a hum voltage equivalent to the hum voltage induced into the voice coil. It is necessary that this coil be connected in a certain manner to accomplish this purpose. If hum is excessive, check this winding to make sure that the leads have not been reversed at some time when repairs were made. Try reversing the leads as indicated; disconnect the set when reversing the leads.

SERVICE HINTS FOR STUDENT EXPERIMENTERS

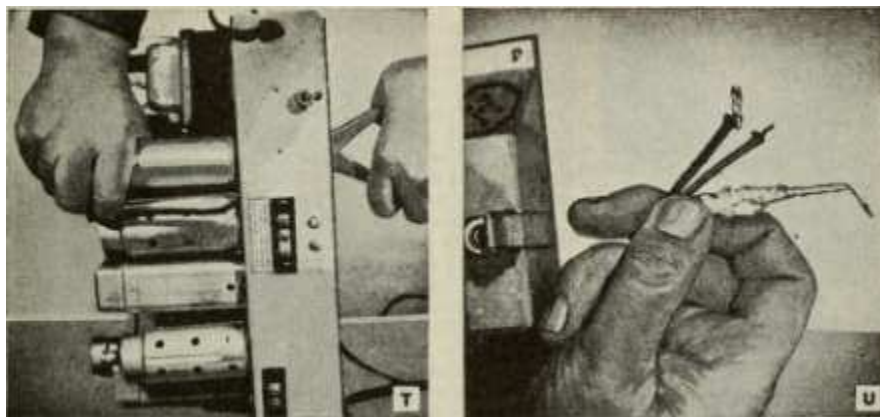


Photo T —Hum in a radio receiver may be due to a poor contact connection where the metal can of the electrolytic filter condenser is grounded on the chassis. First disconnect the set line cord from the wall outlet; the metal can may be held by one hand and the other hand used to tighten the holding nut under the chassis as illustrated. Care must be taken not to damage the insulation on any wires under the chassis.

Photo U —Older receivers that use a line-cord resistor sometimes become inoperative due to the resistor lead grounding on the chassis. As may be noted in the photo, this resistor carries an asbestos covering that is easily damaged. Carefully insulate this resistor under the chassis and see that it does not move when the line cord is pulled.

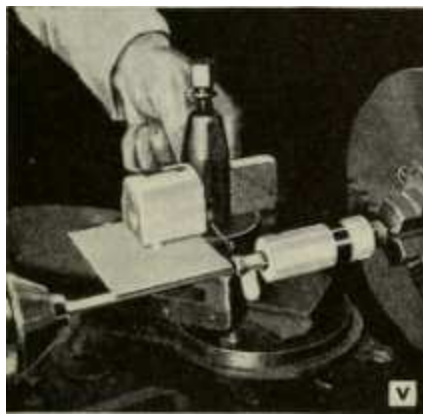


Photo V —Although radio experimenters usually wind coils by hand, ^ome who are fortunate enough to own a lathe and winding counter rig a winding setup like the one illustrated. The coil shown is being wound on a dry wooden form gripped in the chuck by means of a threaded rod passed through the form and held by nuts at each end. At the outboard end of the rod is a small "dog" which is also clamped in place by a nut. The "dog" rotates with the form and trips the counter, recording each revolution. Bakelite coil forms may be wound by clamping a wooden cone in each end of the form.

Photo W —Many coil shields have spring clips which place a tension between the shield and chassis for good contact. Such contacts may loosen and cause fading or oscillation. Adjust the spring clips with pliers as illustrated to reestablish good contact.

SERVICE HINTS FOR STUDENT EXPERIMENTERS



Tuning dial repairs are not difficult if proper precautions are taken to avoid disturbing the calibration of the dial and pointer. A convenient method of marking the pointer position before removing it from the shaft is illustrated in photo A. With the variable condenser plates fully meshed, place a small strip of adhesive tape on the dial and make a mark directly opposite the end of the pointer. It is then a simple matter to replace the pointer in the same position after the repairs have been made.

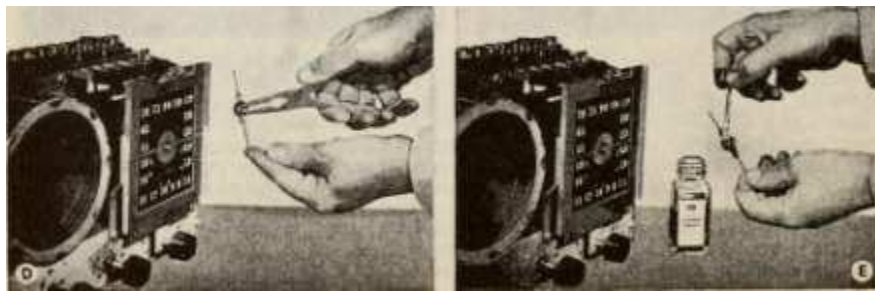
After removing the pointer and dial plate a new drive cable may be indicated if it is badly worn or too loose. If so, make a diagram of the dial-drive cable assembly, tracing the cord wrapped around the tuning shaft and drum as shown in photo B, before removing the dial cord; this will save time and avoid en-ors.

Even if the cord is broken it is often possible to determine its operation before removing the old cord. The system shown is fairly simple; others are more involved. If the dial cord merely is loose and slipping, a repair may sometimes be made by cutting off a small portion of one of the springs as indicated in photo C. When this spring on the end of the cord is reconnected to its hook on the dial drum, more tension will be placed on the cord. Another temporary repair is to apply rosin or a kitchen cleanser powder to the cord. Heavy fishline will often make an emergency cord or cable repair if standard dial cable is not available. Some receivers use special stranded phosphor bronze cable, others heavy linen cord. Permanent repairs on such receivers can be made by any well equipped experimenter or radio service man.

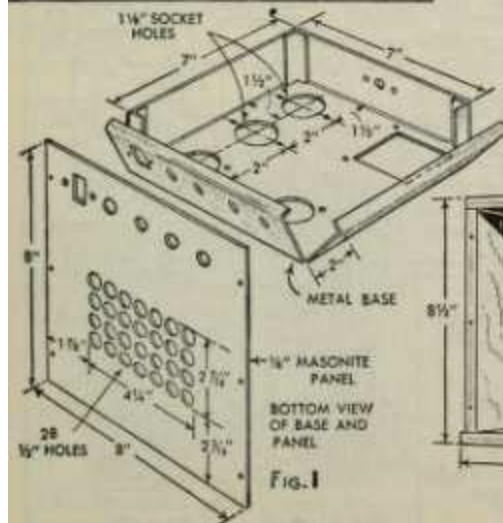
Loose dial pointers or indicators may be repaired by bending the clasps which fit over the shaft with a pair of long-nose pliers, as illustrated in photo D, to obtain a tight fit. Sometimes a light application of service cement, of the type used to repair speaker cones, is necessary, as indicated in photo E. In all cases when the pointer is replaced on the shaft make certain that the condenser plates are fully meshed and that the pointer is lined up with the guide mark. Install the set in its cabinet carefully and make sure that all chassis mounting screws under the cabinet are replaced correctly.

Before tightening these mounting bolts check to see that the dial is properly centered in the cabinet opening; also that the shafts of the various controls are centered in the holes in the front of the cabinet. If the chassis "floats" on soft rubber bushings the mounting bolts should not be fully tightened.

.-,w^m^, JC



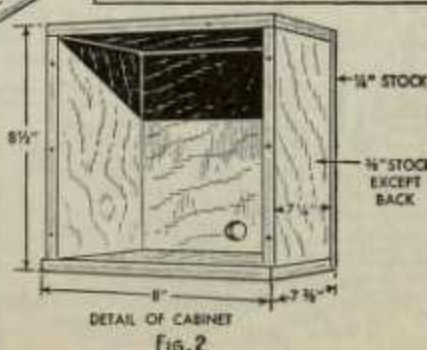
RADIO TESTING UNITS



SIGNAL tracing means to sample or examine the signal at any specified point on its journey through the various stages in a receiver to the loudspeaker. It is a modern method of servicing radio sets; when you pass from a point of normal signal to the point at which this "electronic bloodhound" verifies or confirms the complaint, you have just passed into or through the defective stage. In other words, this signal tracer will quickly enable you to locate the defective stage and, in many cases, the defective part itself. It also enables you to listen to the actual signal as it is traced through the set and provides a means for checking the quality of the signal at each sampling point. This approved method of set servicing is in common use.

It is easy to build and simple to use as it is merely an audio amplifier with a built-in power supply and a nonlinear detector in the form of a probe. The unit illustrated consists of two amplifying stages employing one 6SH7 tube and one type 6K6-GT tube. The nonlinear detector probe, which is housed in a short length of Bakelite tubing, is connected to a 6-ft. length of 3-conductor cable, in which one lead is shielded. It employs a 6C4 tube; the cable terminates in a type P-303-CCT Jones plug. Since this is a grid-leak type of detector, it also adds considerably to the signal amplification. A 5Y3-GT/G tube is used in the conventional built-in power supply, with the additional condensers C11 and C12 employed to

| RESISTORS | |
|--|--|
| 1-10-megohm, 1/2-watt carbon, R1 | |
| 1-310,000-ohm, 1/2-watt carbon, R2 | |
| 1-2.7-megohm, 1/2-watt carbon, R3 | |
| 1-310,000-ohm, 1/2-watt carbon, R4 | |
| 2-1-megohm, 1/2-watt carbon, R5 and R6 | |
| 1-680-ohm, 1-watt carbon, R7 | |
| 1-10,000-ohm, 1/2-watt carbon, R8 | |
| 1-100,000-ohm, 1/2-watt carbon, R9 | |
| 1-3.3-megohm, 1/2-watt carbon, R10 | |
| 1-200,000-ohm, audio taper volume control R11, with a 500K switch (Mallory-type NR 45 with Mallory M26 switch also in model) | |



SIGNAL tracing means to sample or examine the signal at any specified point on its journey through the various stages in a receiver to the loudspeaker. It is a modern method of servicing radio sets; when you pass from a point of normal signal to the point at which this "electronic bloodhound" verifies or confirms the complaint, you have just passed into or through the defective stage. In other words, this signal tracer will quickly enable you to locate the defective stage and, in many cases, the defective part itself. It also enables you to listen to the actual signal as it is traced through the set and provides a means for checking the quality of the signal at each sampling point. This approved method of set servicing is in common use. It is easy to build and simple to use as it is merely an audio amplifier with a built-in power supply and a nonlinear detector in the form of a probe. The unit illustrated consists of two amplifying stages employing one 6SH7 tube and one type 6K6-GT tube. The nonlinear detector probe, which is housed in a short length of Bakelite tubing, is connected to a 6-ft. length of 3-conductor cable, in which one lead is shielded. It employs a 6C4 tube; the cable terminates in a type P-303-

CCT Jones plug. Since this is a grid-leak type of detector, it also adds considerably to the signal amplification. A 5Y3-GT/G tube is used in the conventional built-in power supply, with the additional condensers C11 and C12 employed to take

V*" STOCK

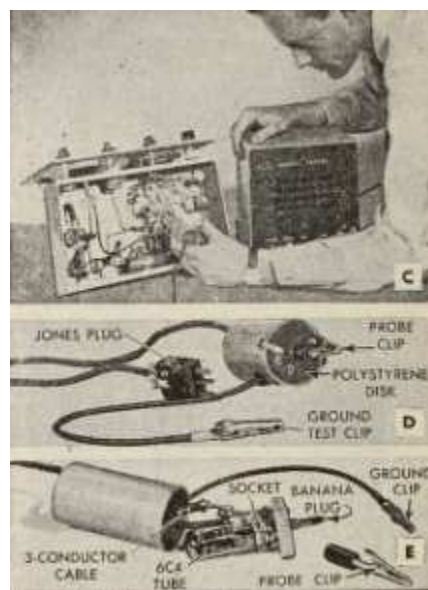
%" HOLES

DETAIL OF CABINET

SIGNAL TRACER FOR RADIO SERVICING

out line noises which might appear in the signal tracer, because of its high amplification. Photos A, B, F, G and H show various views of the completed instrument. The metal chassis base, Masonite panel, and cabinet are all carefully detailed in Figs. 1 and 2. A complete schematic circuit diagram is given in Fig. 3. Pictorial wiring diagrams of the 6C4 tube socket, probe and cable connections are shown in Figs. 3-A and 3-B. Condenser CI, resistor R1 and the 6C4 miniature tube are all contained within a 1/2-in.-dia. piece of Bakelite tubing which is closed at each end with a disk of 1/4-in. polystyrene. This is a clear plastic insulating material that is available from all radio-parts houses. Condenser CI consists of two pieces of insulated hookup wire 1/4 in. long twisted together to provide a necessary small capacity; note that only one end of each wire is connected, as indicated in Fig. 3-B. Photos D and E show the completed probe and cable. The banana plug is the actual probe which is used to contact the various parts of the receiver. It picks off either an r.f., i.f., or audio signal. For r.f. or i.f., the signal can be

WWr^



3-CONDUCTOR CABLE

BANANA PLUG SEE^EXT (WITH %" LONG

BANANA-JACK TYPE

ALLIGATOR CLIP FOR CONNECTING -PROBE TO CIRCUIT UNDER TEST

NOTE-TUBE SOCKETS, BOTTOM VIEW N.C.=NO CONNECTION --t-- =GROUND ON CHASSIS ELECTROLYTIC CONDENSERS C6, C7 AND C8 ARE IN A TRIPLE-SECTION MALLORY-TYPE FP-367 ALUMINUM CAN ON TOP OF BASE

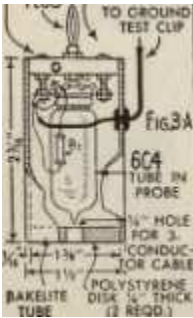
OPEN-CIRCUIT PHONE JACK

6 - 32 SCREWS /' %" LONG BANANA PLUG

PROBE

(TO GROUND V TEST CLIP

V

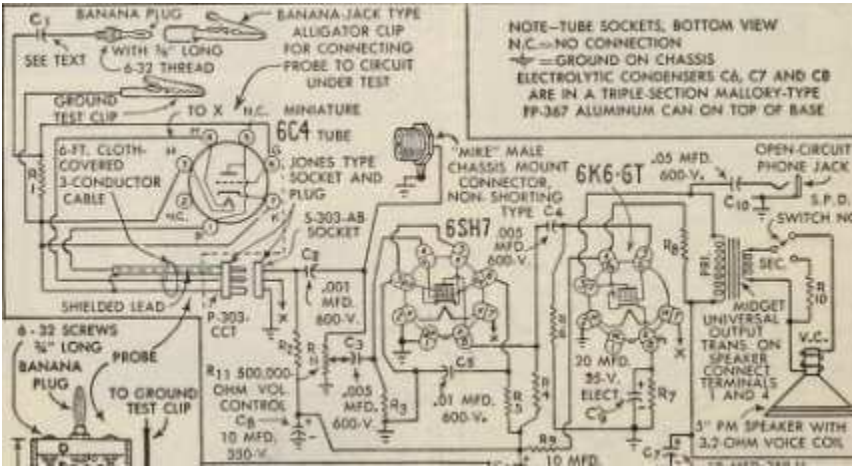


(POLYSTYRENE

DISK %" THICK

(2 REQD.)

SWITCH NO. 1



TWISTED WIRES ^,,^ ^^^^q, ^^^

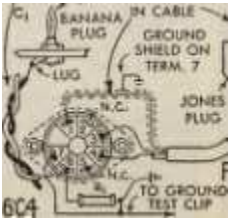
C, /;\-^nANA;N CABLE ^xr*i*

PLUG / GROUND ff//*l* SHIELD ON *i* TERM. 7

JX*i*, /*I*

JONES

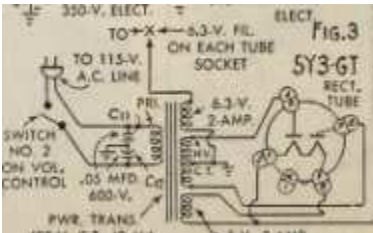
PLUG y FIG.3B



C6±

5" PM SPEAKER WITH JF" 3.2-OHM VOICE COIL

II*i*:"V,10 MFD.350-V. ~ ELECT.



480-V. C-T, 40 MA

SIGNAL TRACER FOR RADIO SERVICING

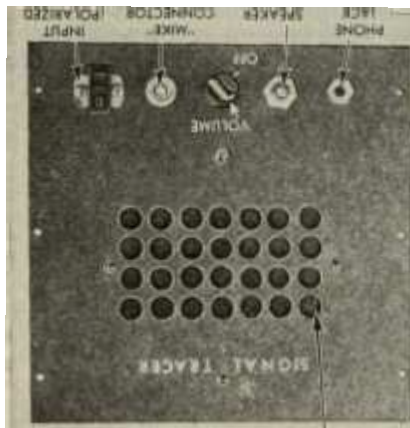


SPEAKER-GRILLE HOLES V*j*" I N DIA.

PHONE 1 "MIKE" INPUT

1 JACK SPEAKER CONNECTOR (POLARIZED

! G ' SWITCH NO. 1 JONES SOCKET!



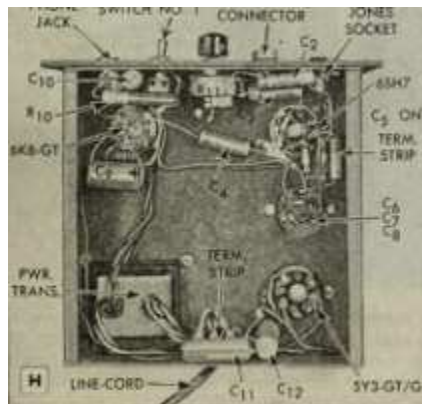
detected in the 6C4 tube and converted to audio where it is further amplified in the other two tubes for operating either a loudspeaker or a set of headphones. Switch No. 1 cuts in dummy load when phones are used. With the microphone connector you have a 2-stage public-address amplifier should the emergency ever arise.

When arranging the parts on the chassis base, mount them so as to make all connections between the various terminals as short as possible. All "hot" wires associated with the output circuit, such as the plate side of the 6K6-GT, must be well separated from any wires associated with the input or grid side of the 6SH7 tube. Leads and components connected to grids or plates of either tube should have the shortest possible length; clip the pigtails of resistors and condensers where necessary to keep these leads short. In common practice, the signal tracing procedure is to work backwards from the loudspeaker towards the antenna circuit. Always guard against possible shock by disconnecting the receiver from the power line and use the alligator clips to make the necessary circuit connections each time the probe is moved. Assuming that you have a "dead" receiver but your meter indicates plate and filament voltage to the tubes, you begin with your signal tracer by connecting the ground clip to the chassis of the set and

check at the speaker voice-coil leads. Then go to the plate terminal of the output stage and next to the grid terminal of the output stage, etc., until something is heard in the loudspeaker of the signal tracer. The best points of contact are usually the grids or plates of each of the tubes (except the power-supply rectifier tube), checking every tube all the way back down the line until the signal is heard. When the signal is heard, this is your indication that immediately following this point, there is a failure in the receiver itself. Thus, by process of elimination, you are able to find the cause of the trouble. The instrument is light and easily portable. A chrome drawer-pull handle can be mounted on the top of the case. The rugged case as detailed in the diagram Fig. 2, will stand up under rough handling.

SPEAKER PHONE SWITCH NO, 1 JACK.. ^

"MIKE" CONNECTOR



UTILITY VOLT-OHM CHECKER

T^HE MOST useful test instrument for the student ^ and experimenter is a volt-ohm checker. The volt-ohm-milliammeter in photos A and B was built by students as a class project.

A two-deck 12-point rotary-type switch is used for selecting the various positions. A small Bakelite plate, 1% X 2 in., with the fixed resistors attached is mounted on the back of the rotary switch, and the wiring is quite simple. All parts values are identified in the diagrams; the fixed resistors are all V2-watt carbon types except the special resistors .505-ohm and .05-ohm marked by stars in Fig. 1. These special resistors were assembled by using two IVz-megohm resistors for the forms. Resistance wire was wound on these forms and measured on a bridge to obtain .05 and .505 ohm. About 2 in. of No. 16 resistance wire was used for .05 and about 2 in. of No. 26 for .505. The wire was then soldered to the resistor leads, actually placing the two resistances in multiple, but due to their high value no difference would be observed in the smaller values. The 5.55-ohm resistor was made by connecting two 11-ohm carbon resistors in parallel; the 5000-ohm variable resistor is a midget linear-taper type. Two pointer-type dial knobs, a set of test prods and a 0-1 milliammeter complete the assembly which is made in a metal case SVz x 4 x 5 in. deep. The meter is mounted in the lid. If the builder prefers to make a wooden case, it can be built of y4-in. plywood.

The case is large enough to house the IVa-volt flashlight cell and a Burgess type U-IO-E. or similar, 15-volt battery. Dial scale for the switching points,

5K.OHMS <-'2K.OHMS



950 OHMS 50 OHMS _

No. 2 CELL 1.5-V. BAT.

TWO-DECK ^ 12-POSITION n (EACH DECK) -f-i . SWITCH

0-1 MA.

50 OHMS

INTERNAL

.RESISTANCE^

I

10 OHMS 1/10 V.

ALL RESISTORS $\pm 1\%$

DIAL SCALE NOTE: p.

• K - THOUSAND Fij- 2

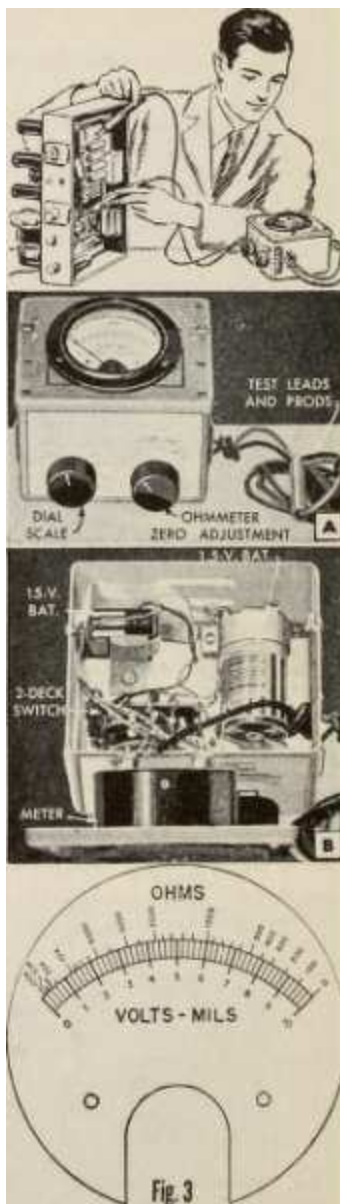
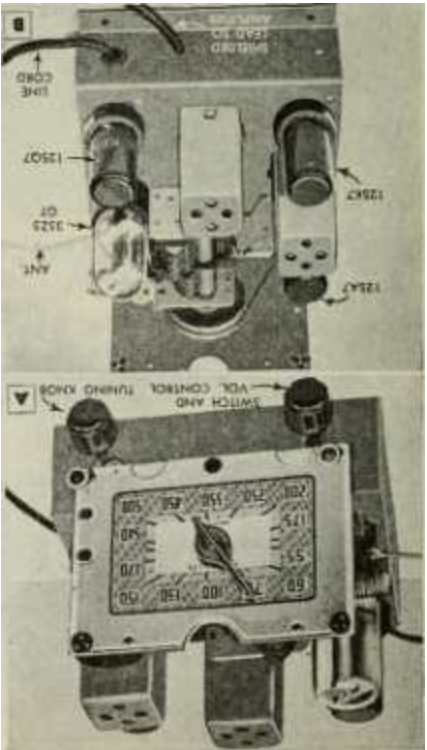
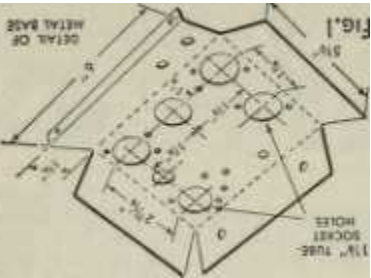


Fig. 2, and the zero adjustment arrow may be made on a strip of paper and pasted on the case as indicated in photo A. The meter-dial scale, to replace the original scale on the 0-1 milliammeter, is shown in Fig. 3 if you are using a 2-in. meter. If your meter is larger, make a photostat enlargement to the required size. If the resistor values are as specified, no-alterations in the scale will be necessary.



UNUSUALLY compact and highly efficient, this AM super tuner will provide the owner of any public-address system with a means for supplying "on the spot" radio music, news and public events at picnics, ball games, meetings or wherever PA systems are used. It also makes an ideal addition to sound installations of the type used in industrial plants for playing recordings for employees. It may be employed as a remote tuner for any radio receiver that is equipped with phono input jacks or with any audio amplifier. The antenna coil is a Carron No. S407 or any small universal type; the intermediate-frequency (i.f.) transformers and oscillator coil are all Meissner types. Note in photo C that the antenna coil is mounted horizontally above the base by soldering its ground terminal, No. 4, directly to the front of the

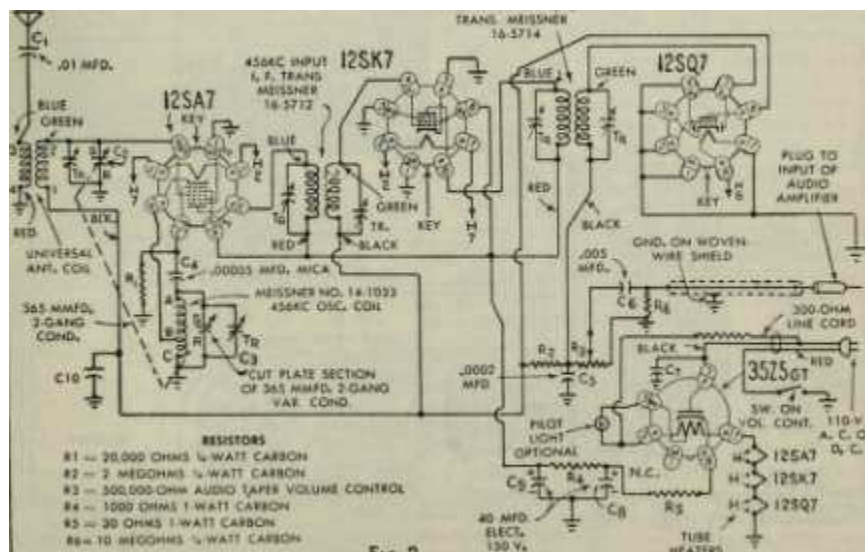
I/s" TUBE. SOCKET HOLES



DETAIL OF METAL BASE

456KC OUTPUT I. F.

TRANS MEISSNER



RESISTORS

$R_1 = 20,000 \text{ OHMS } 1/4 \text{ WATT CARBON}$

$R_2 = 2 \text{ MEGOHMS } 1/4 \text{ WATT CARBON}$

$R_3 = 500,000 \text{ OHM AUDIO TAPER VOLUME CONTROL}$

$R_4 = 1000 \text{ OHMS 1-WATT CARBON}$

$R_5 = 30 \text{ OHMS 1-WATT CARBON}$

$R_6 = 10 \text{ MEGOHMS } 1/4 \text{ WATT CARBON}$

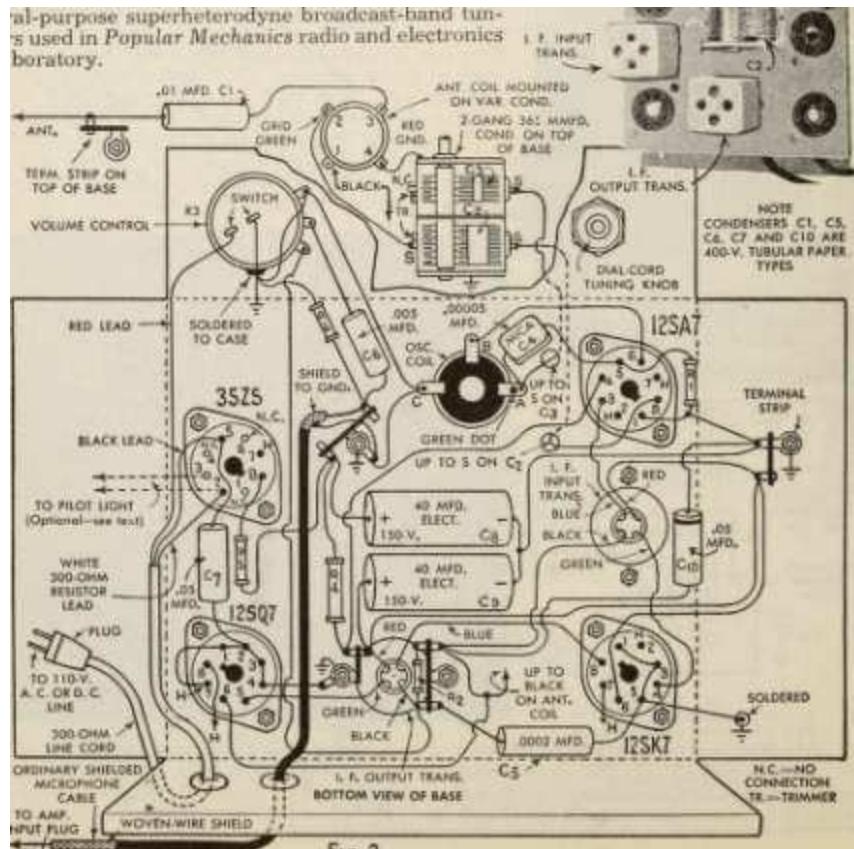
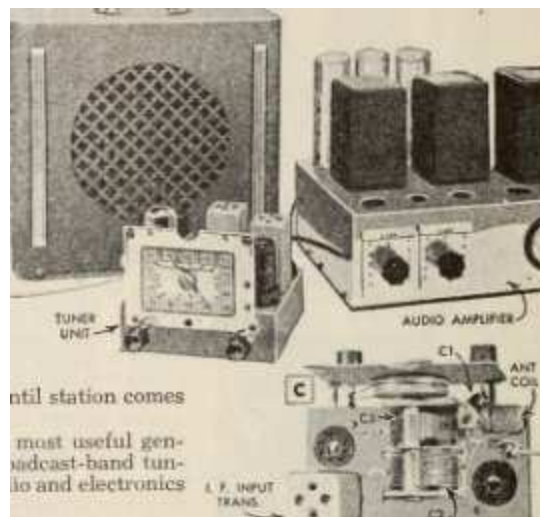
FIG. 2

FOUR-TUBE SUPER BROADCAST TUNER

variable condenser frame. This connection is indicated with a wire lead in Fig. 3.

To balance the tuner unit, connect the antenna and audio amplifier; tune in a station at about 670 kc. The i.f. transformers are factory peaked and require very little adjusting—just a slight trimmer adjustment to bring in the station at maximum volume. While still tuned to this station, adjust the trimmer on C3, the oscillator cut-plate section, to bring in the station at the proper dial reading. Now tune in a station at about 1400 kc. and adjust trimmer C2 on the antenna-tuning condenser section until station comes in at maximum volume.

This is one of the simplest and most useful general-purpose superheterodyne broadcast-band tuners used in Popular Mechanics radio and electronics laboratory.



ORDINARY SHIELDED MICROPHONE CABLE TO AMP. INPUT PLUG

FIG.3

HIGH-FIDELITY FM TUNER UNIT

view of the chassis showing the binding post strip for an FM dipole antenna, and the audio output cable which is fastened to the chassis base by means of a clamp. A front view of the completed FM tuner appears in photo

C. It may be housed in a standard stock cabinet or installed in a custom-made or home-built console combination. The chassis layout is shown in Fig. 1 and the dial-string detail in Fig. 2. A complete schematic circuit diagram appears in Fig. 3 All coils are of the reliable Meissner type, and every part is carefully selected to insure maximum results. Very little leeway in specifications can be tolerated in high-frequency FM circuits and the parts specifications given in Fig. 3 are those that are supplied in the complete kit shown in photo

D. Those who do not wish to purchase the complete Meissner T-8CK kit shown in photo D can buy foundation parts which consist of the essential Meissner units. These are as follows: FM tuning assembly (catalogue number 13-7628) with dial parts and hardware; main chassis base (No. 05965-A); power transformer (No. 29501); FM-i.f. transformers (No. 05452), and the ratio detector coil (No. 05453). The i.f. coils and the ratio detector, when supplied separately, are not prealigned.

A bottom view of the completed FM tuner unit is shown in photo E. Before the operation of an FM receiver is described, it is well to review briefly the theory of FM transmission. Unlike amplitude-modulated (AM) transmission in which the r.f. wave varies in amplitude to correspond with the impressed audio signal, frequency-modulated transmission does not affect the amplitude of the wave. It permits the wave amplitude to remain constant but varies

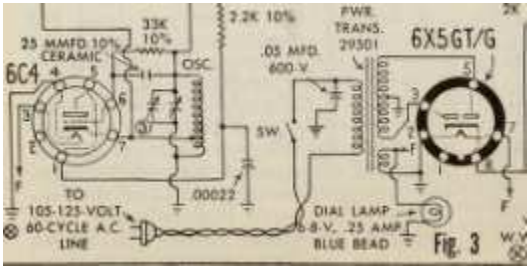
HIGH-FIDELITY FM TUNER UNIT

wave frequency in accordance with the modulated signal, as illustrated in Fig. 4. If the carrier frequency of an FM broadcast station is, for example, 88 megacycles, its frequency under modulation may shift as high as 88,075 kc. and as low as 87,925 kc, a swing above and below 88 megacycles (88,000 kc.) of 150 kc. From this it can be seen that a single FM broadcasting station may cover a band width in the radio-frequency spectrum of as much as 150 kc. This is why FM broadcasting stations are located in the ultra-high-frequency bands where there is a great deal more room for wide-range high-fidelity transmission than in the regular broadcast band.

Designed by well-known radio engineers especially for students and experimenters, this FM tuner circuit employs a double converter system which greatly reduces image response. The detector circuit, built around the 6AL5 tube, is called a "ratio detector." It develops an audio voltage that is proportional to the ratio of the swing in frequency above and below the average frequency, during frequency-modulation (FM). It responds only to FM signals, not to amplitude-modulated (AM) signals and, since static and other electric disturbances

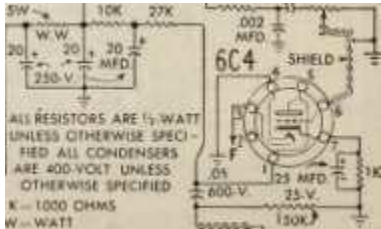
6X5GT/G

J



22K o' 500K

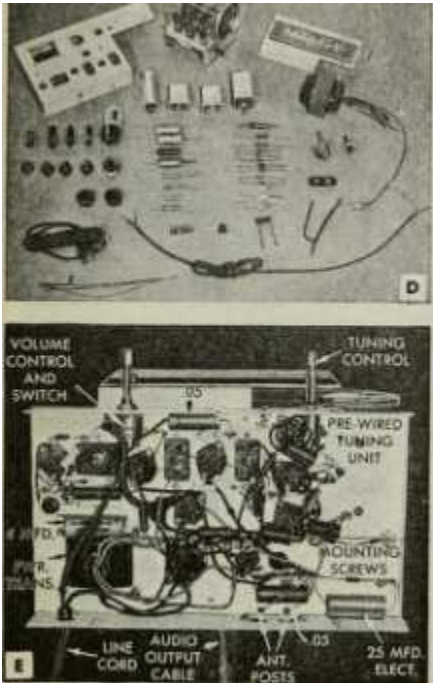
ALL RESISTORS ARE 1/2-WATT UNLESS OTHERWISE SPECIFIED ALL CONDENSERS ARE 400VOLT UNLESS OTHERWISE SPECIFIED K 1000 OHMS W .:WATT



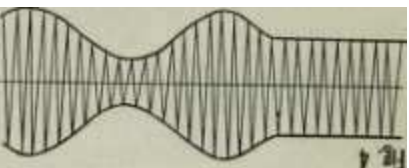
W.W.-WIRE-WOUND JIV AUDIO OUTPUT

COMMON FILAMENT GROUND" CABLE

HIGH-FIDELITY FM TUNER UNIT



AMPLITUDE MODULATION - FREQUENCY REMAINS CONSTANT AMPLITUDE IS MODULATED



FREQUENCY MODULATION - AMPLITUDE REMAINS CONSTANT FREQUENCY IS MODULATED



are principally amplitude modulated, they are not reproduced, thus the performance of the FM receiver is noise-free.

The input or antenna coil tunes the entire FM band from 88 to 108 megacycles. The oscillator involving the 6C4 tube, shown at lower left in the circuit diagram, beats with the incoming signal to produce a lower frequency signal. The oscillator voltage is fed into the main receiver circuit at two points, in series with the cathode of

the first 6AG5, and in shunt with the input grid of the second 6AG5 tube. After the second 6AG5, the signal is at 10.7-megacycle frequency and is amplified by the two following 6BA6 i.f. tubes.

Just above and to the left of the 6C4 audio-amplifier tube, shown at lower right in the circuit diagram, is a 22,000-ohm resistor and a .002-mfd. condenser. This is the de-emphasis circuit of the FM receiver. FM signals are transmitted by the station with the higher frequencies accentuated. At the receiver these higher frequencies must be attenuated to provide a perfectly flat response. Any noise in the circuit is also reduced at this point.

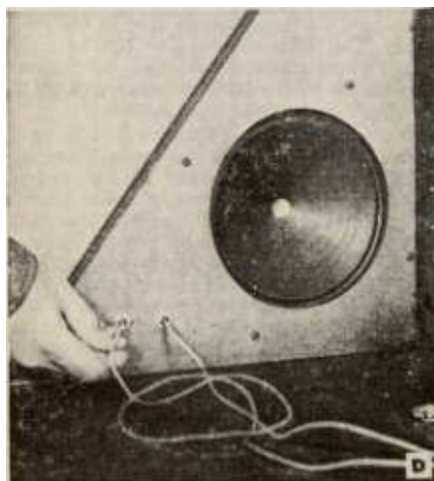
A full-wave rectifier is employed in the a.c. power supply, and the filter circuit is a resistor-condenser type. The output of the 6C4 amplifier tube is approximately 7 watts maximum. This is just right for use with any phono amplifier, power amplifier or good radio set having phono input te mi-nals. Because of the high frequencies involved in FM reception, it is desirable to use a standard outdoor FM antenna, which should be mounted as high as possible. Those who wish to make an indoor FM di-pole antenna that will give good results in strong FM signal areas can do so by using a short length of 300-ohm Amphenol twin lead. This is the same transmission-line material that is used for both FM and TV antenna lead-ins. Cut off a 57-in. length of the twin lead and bare the wires at each end just enough to twist them together and then solder these ends. Then lay the twin lead out flat and cut the lower wire in the exact center; bare the ends of this wire about y2-in. and tin them for soldering to the twin-lead transmission line to the receiver. This

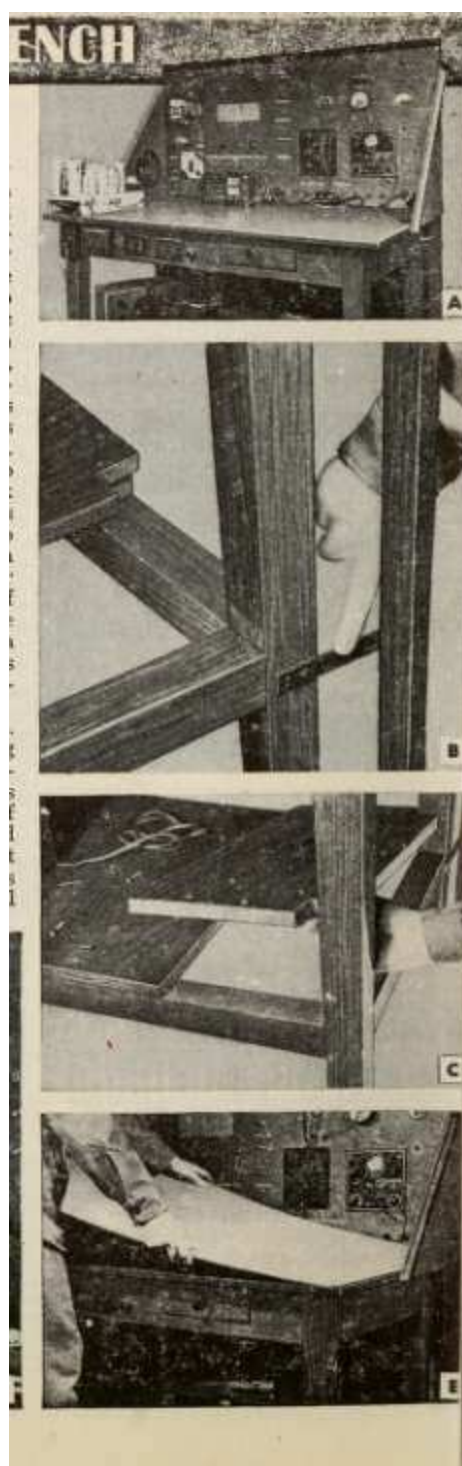
transmission line can be any length up to about 100 ft. You can fasten the antenna to any table or baseboard with the dipole broadside to the station.

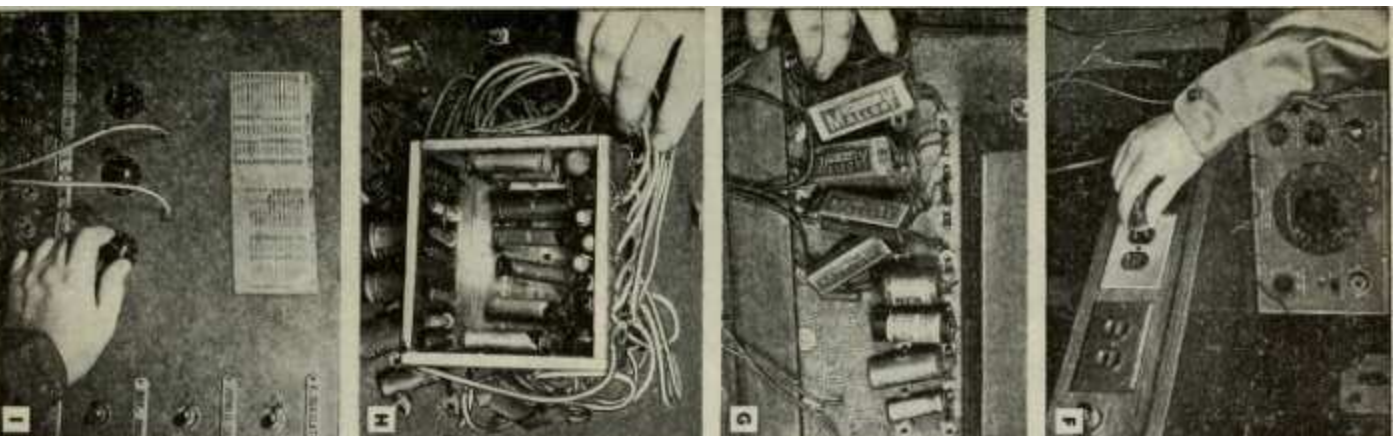
This is often a good solution for the antenna problem when a roof installation is not practical; the twin-lead dipole can be tied with string to a horizontal collar beam in the attic. A twin-lead dipole of this description makes a good emergency FM antenna in an apartment house where roof antenna systems are not permitted. Merely fasten it to the picture molding with thumbtacks on the wall of the room that is broadside to the FM station. In some cases on upper floor apartments it can even be placed under a rug if there are powerful FM stations broadcasting in the vicinity. The length of the dipole is cut to 56½ in. as this is about the center of the FM band.

THAT old flat-top desk that is gathering dust in the attic can be made into a good radio workbench which will be useful in handling repair work or tests and experiments of various kinds. Any ordinary sturdy wooden table of similar size may be used. The completed bench shown in photo A serves many useful radio and electronic testing purposes and it was built around a secondhand flat-top desk about 4 ft. long, 27 in. wide and 29 in. high. A piece of ½-in. hardboard, 4 ft. long and 2 ft. wide, is used for the back panel. This panel was reinforced around the edges with 1 x 2-in. wood strips at the rear and then nailed to the desk top. In order to make the back panel rigid, the two vertical wooden strips were extended to the floor and attached to the desk legs with flat iron as illustrated in photo B. The panel mounting was further strengthened with triangular side pieces of hardboard and wood strips. One of these supporting side pieces is used to mount a permanent-magnet-type loudspeaker as illustrated in photo D. Test leads are connected to the speaker through pin jacks.

The desk legs are braced with 2 x 2-in. wood supports all the way around, using angle-iron brackets and screws. A covering of 1-in. lumber was then installed as indicated in photo C, thus providing shelf space for tool kits, power-supply units and portable testers. A B-voltage supply unit is located on this bottom section and it is wired to a control switch and terminal



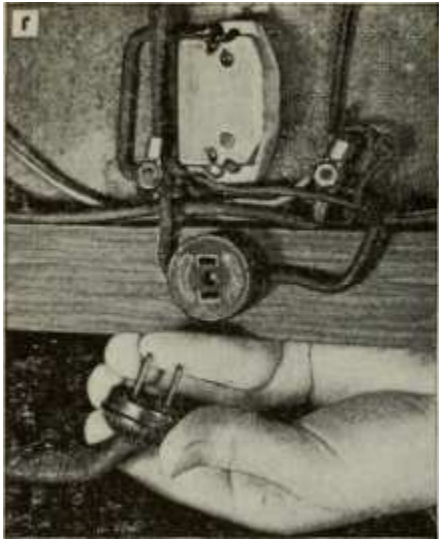




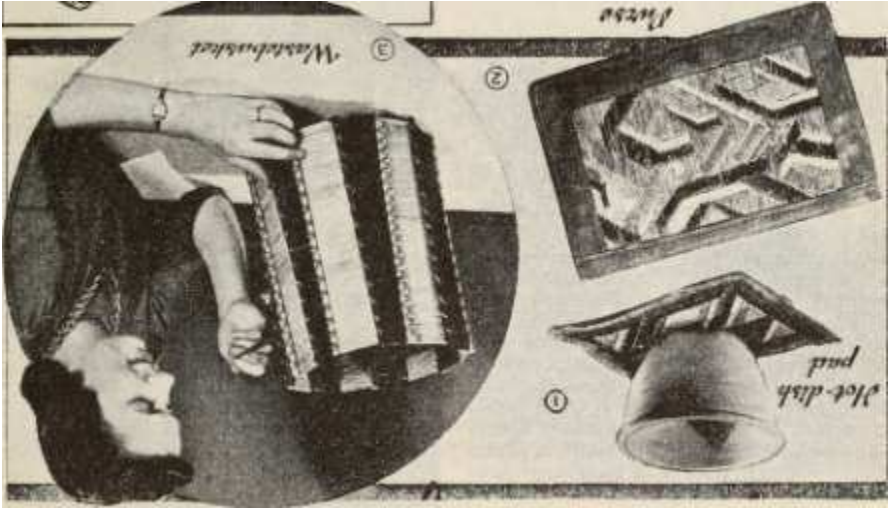
posts for various B-voltages on the panel front. An eliminator for testing auto radios is also included; a heavy-duty toggle switch is mounted at top center to control the entire panel. This switch is fed from an outlet to which is attached a plug with a heavy cord extending to a wall outlet, as illustrated in photo J. In order not to leave the bench energized when not in use, a red panel lamp is located in the front of the desk frame and connected across this main panel switch. Outlet receptacles on the desk front are for connecting sets, testing equipment and soldering irons. These are installed as indicated in photo F. The desk top may be covered with a large sheet of hardboard if desired, as illustrated in photo E. This will protect the top, and also provides a good working surface.

For convenience in testing, a number of fixed condensers, from .01 to 16 or 20 mfd., were mounted on the back panel and wired to pin jacks, accessible from the front as illustrated in photos G and I. A number of fixed resistors were likewise arranged on the rear of the

back panel as shown in photo H and these were connected through rotating switches to two pin jacks or tip jacks mounted on the front of the panel. Photo I shows test leads plugged into these jacks. The charts show the values of the various rotary switch settings in ohms. Other equipment on the test panel includes a watt-hour meter wired to an outlet on the desk front. This is used for checking current consumption of appliances. Other units on the panel include a tube tester, condenser tester, ammeter, milliammeter, ohmmeter and various switches and terminal strips.



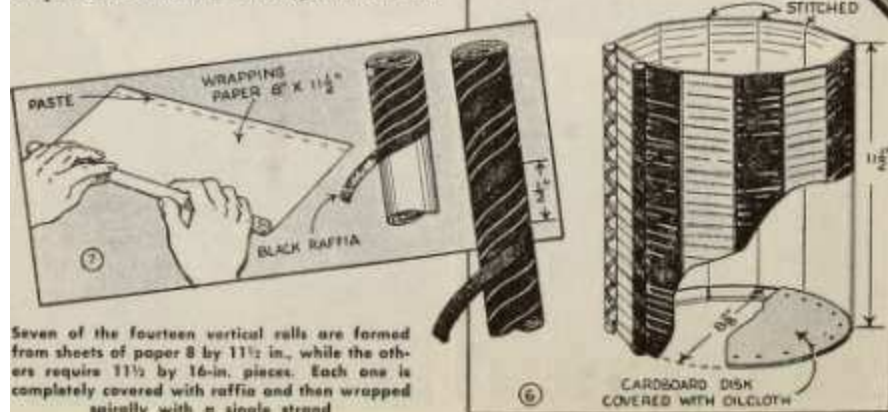
RAFFIA WEAVING



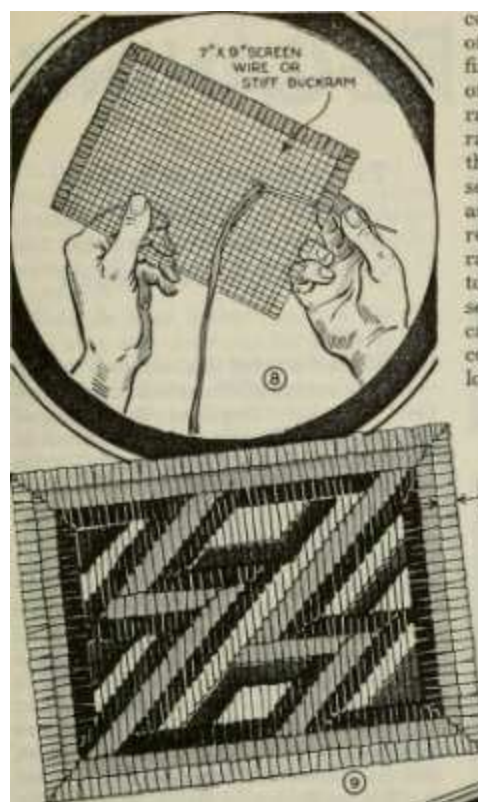
F) AFFIA need not be restricted to basket-making alone. You'll find the material suitable for weaving many other useful articles such as hot-dish pads, attractive overlays for hand bags, coin purses, wastebaskets, etc. Figs. 1, 2, 3 and 11 show a few examples of what can be done. The wastebasket is made up of fourteen panels of fairly stiff cardboard. Each one is wrapped with raffia as in Fig. 4, seven of them being covered in black and seven in yellow. Before covering, each strip is scored with a knife $\frac{1}{2}$ in. from one

Seven of the fourteen vertical rolls are formed from sheets of paper 8 by 11" 2 in., while the others require 11" 2 by 16-in. pieces. Each one is completely covered with raffia and then wrapped spirally with a single strand

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Seven of the fourteen vertical rolls are formed from sheets of paper 8 by 11 1/2 in., while the others require 11 1/2 by 16-in. pieces. Each one is completely covered with raffia and then wrapped spirally with a single strand



COLOR KEY

ORANGE LIGHT GREEN BROWN YELLOW BLUISH GREEN

cover the seams as in Fig. 6. First, sheets of wrapping paper are rolled tightly into a firm

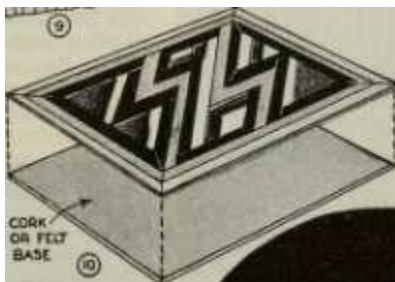
roll and pasted along the edge. Seven of these rolls are fully wound with black raffia, after which a single strand of red raffia is wrapped spirally over the black the full length of the roll as in Fig. 7. The seven other rolls are done in yellow raffia and then wrapped with a double spiral of red—that is a second strand is wound spirally in a reverse direction from the bottom to the top. In sewing these over each seam of the basket, use small stitches to catch hold of the raffia, and alternate the colors, placing first a black one, then a yellow and so on. Finally, a cardboard disk with black oilcloth glued to the top is sewed to the tabs at the bottom. The hot-dish mat shown in Fig. 1 may be woven on a piece of common screen wire, or stiff buckram. If the former is used, trim the marginal ends of the wire close to the mesh. First, a double row of stitches about $\frac{1}{2}$ in. wide are overcast around the edge of the mat, using a tapestry needle as in Fig. 8. After this, the center portion is filled in, following the direction of the weave given in Fig. 9, and finally the finished mat is glued to a felt or cork base, Fig. 10.

The mat is completed by gluing cork or felt to the bottom. Cut this slightly smaller in size and press flat under a heavy object until dry

CORK OR FELT BASE

end so that it later may be bent inward easily to form a tab for the bottom. The wrapping is begun at the end opposite the score, using a little paste to secure the starting end. Let each turn overlap slightly the edge of the preceding one, and when the end is reached, the raffia is pasted and tucked under the winding as in Fig. 5.

With the tab ends all facing inward, the panels are sewed to one another with black thread, alternating the position of the two colors. The stitches are made through several rows of raffia the full length of the strip, but not through the cardboard. Now paper rolls are made to



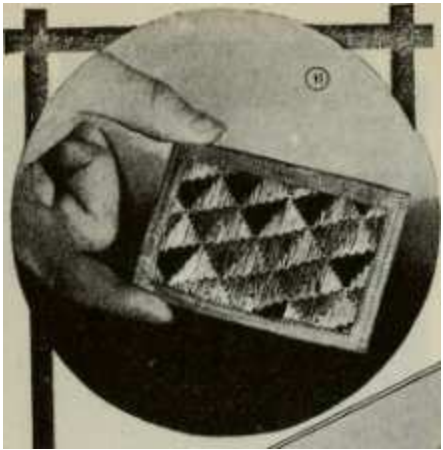
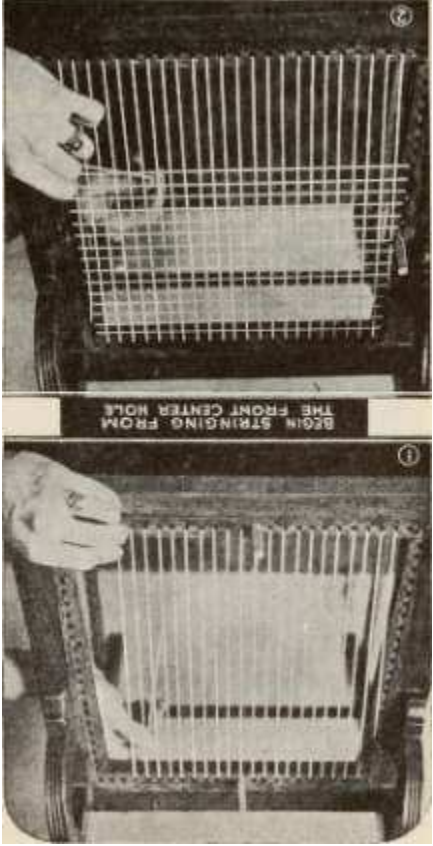
CROSS STRANDS ARE STRETCHED FROM LEFT TO RIGHT

RE-CANING

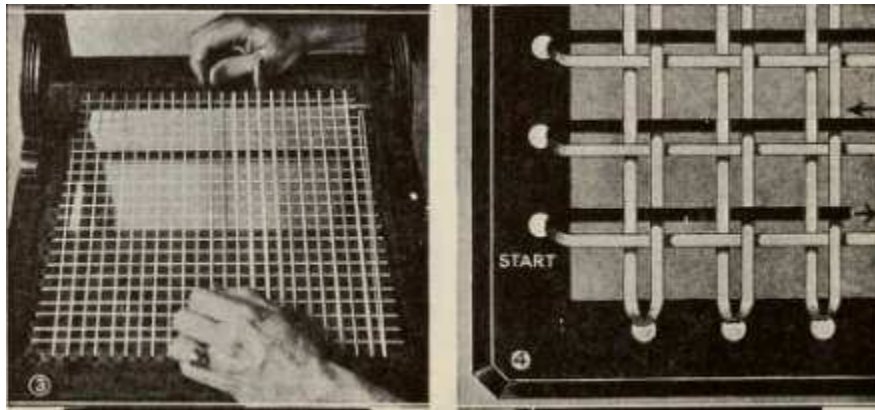
Easily mastered by any beginner. All you buy is the cane as no tools except wood pegs are needed

Why not get out that old rocker from the attic if all it needs is a new seat? Once you have acquired the knack of weaving cane, there's no trouble at all in doing this work and it's a possibility- for making some spare-time profits.

Size of Cane: First you take a piece of cane from the broken seat and go to your furniture dealer so that new cane of the same size can be obtained. If the worn-out seat has been removed, you determine the correct size of cane to get by the size of the holes in the seat frame and the distance they are spaced apart. If the holes are $\frac{5}{6}$ in. in diameter and $\frac{5}{8}$ in.



apart, use a size termed as superfine. When they measure $\frac{1}{2}$ in. apart, use fine; when $\frac{3}{4}$ in. apart, use medium. Quarter-inch holes $\frac{1}{2}$ in. apart require medium and $\frac{3}{4}$ -in. holes, $\frac{1}{2}$ in. apart take common. The two sizes generally used are fine and medium. Cane comes in bundles of 1,000 ft. or half bundles of



ANOTHER LAYER OF STRANDS GOES OVER THE FIRST ONE

THE WEAVING BEGINS- UNDER ONE STRAND AND OVER THE NEXT

^ave^ that old chacM

500 ft. A full bundle will reseal three or four chairs of average size. If you wish to purchase just enough material for a single seat, keep in mind that sixteen single strands will do a seat measuring about 14 in. square.

Cane Is Kept Moist: Remove the old cane seat and clean out the holes in the frame. For tools you need only five or six tapered wood pegs. If the holes are not too large, golf tees will serve for pegs. Each time you are ready to use a new strand of cane, it should be immersed in water for a few moments. This makes it somewhat pliable and easier to work. However, too much soaking makes the cane too limp for easy working. Your hand dipped in water occasionally while handling will keep it sufficiently moist.

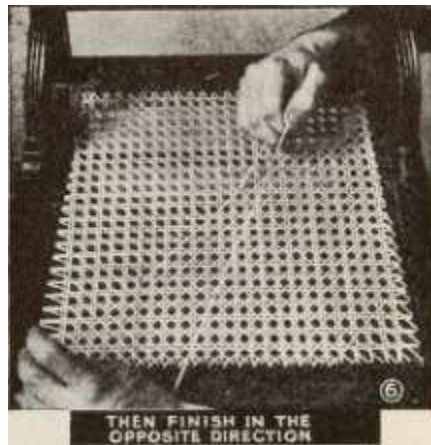
Square Seats Easiest: A square or rectangular seat is easier to weave than a round one. When weaving a round seat, you must skip several holes so that the strands will run parallel. The first step in weaving a square seat is to run the strands vertically from front to back. Start with the center hole in the front rail as in Fig. 1, Insert the strand, letting the end extend about 3 in. below, and hold in place with a peg. Run the entire strand between the thumb and forefinger to keep it from twisting so that the glazed surface will be on top. From the center front hole pass the strand through the center back hole, drawing it firmly but not too taut to break, and fasten with a peg. Bring the end up through the adjacent hole on one side, shift the peg to this hole, and, running the cane through your fingers as before, draw it back to the front rail, parallel to the previous strand, then insert into the hole and fasten with a peg. This procedure is continued until all vertical strands are in place, omitting the corner holes.

The second step is merely a repetition of the first step except that the strands run across the first ones as in Fig. 2. When a strand is nearly used up and is too short to reach across again, peg the end and start



HERES A FINISHED JOB--BOTH SEAT AND BACK ARE RECANED VARNISHING WILL MAKE THIS CHAIR AS GOOD AS NEW

START THE DIAGONAL STRANDS IN ONE DIRECTION



with a new strand. You do not join strands. When all horizontal strands are laced over the Vertical ones, you are ready for the next step.

Fastening Loose Ends: Before starting the third step, you can fasten the free ends of the strands thus far in place by tying to the underside. To do this, wet the end of each strand thoroughly, pass it under one of the loops of cane between the holes and bring it around in a knot. If necessary, a knife blade will aid in slipping the strand under the loop. The third step is a repetition of step one, a second layer of vertical strands being laced over the

horizontals as in Fig. 3.

Actual Weaving Begins: With the next step. Fig. 4, you begin actual weaving. Weaving from left to right, each horizontal strand, indicated in black, is passed under one vertical and over the next adjacent one. Each time you say to yourself "under and over," for each pair of verticals, until you reach clear across. After passing the strand down through the hole and up the next, you are ready to make a return trip from right to left, but this time weaving over and under instead of under and over. In weaving, frequently draw the entire strand up taut.

The Pattern Takes Shape: Next is the fifth step—the diagonals. Fig. 5. Starting at the left front corner hole, work a strand under the double row of horizontals and over the double row of verticals, continuing in a like manner also on the return trip.

By studying a sample taken from the old seat you will be able to correct yourself if you have difficulty. In step six. Fig. 6, you make a diagonal weave in the opposite direction. You use a reverse procedure for this, passing over the horizontals and under the verticals. When this weave is completed, all loose ends are tied to the underside.

Applying the Binding: The binding, Fig. 7, covers the holes around the border of the seat and provides a neat, finished edge. Use a wide strand known as binder. To fasten this over the holes, you use a strand of the same size cane as you have been using for weaving. Skipping every



A BINDING AT THE EDGES COMPLETES THE JOB

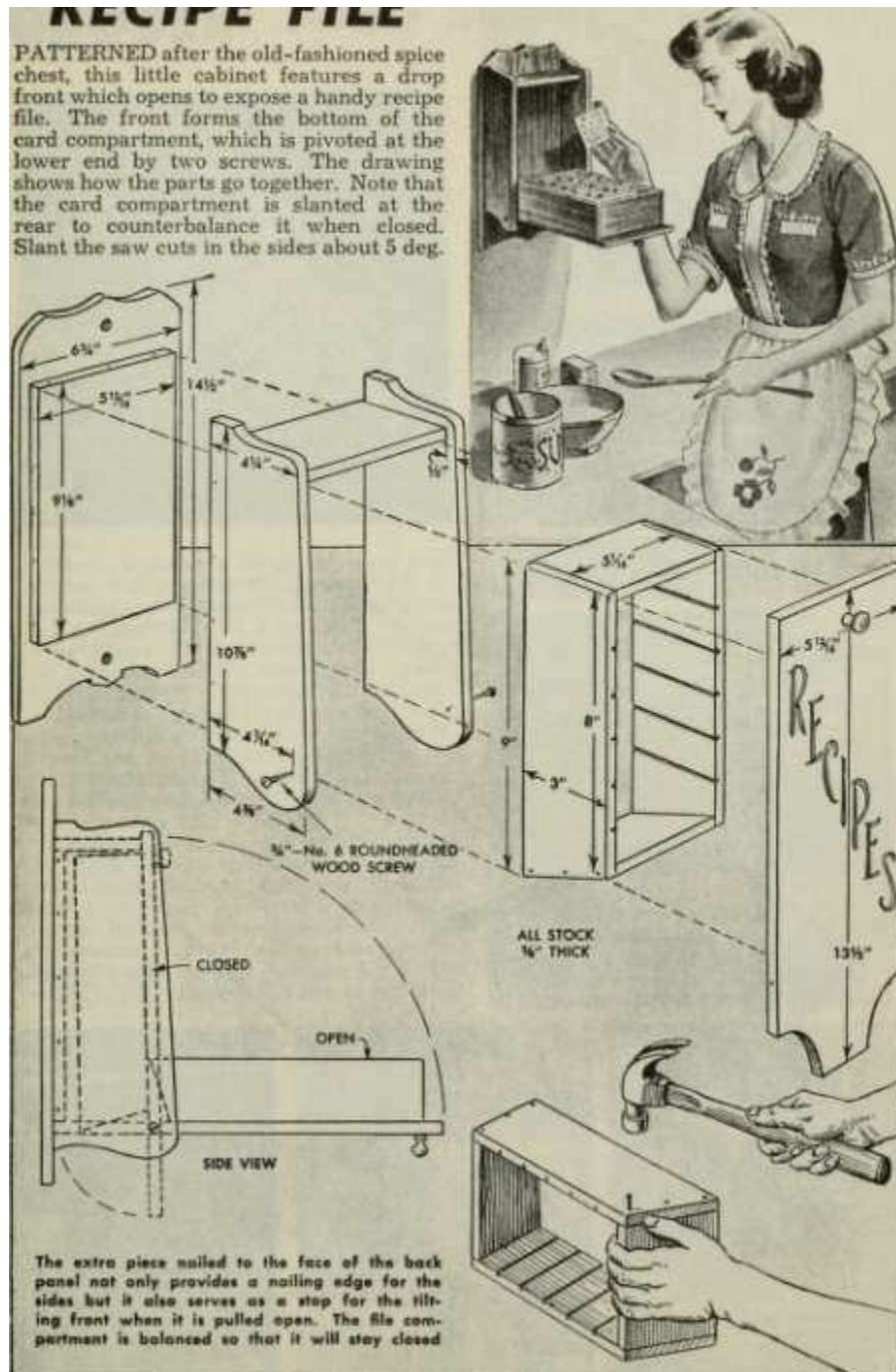
other hole, pass the end up through the hole from the bottom, lay the binder over the row of holes and form a loop around the binder with the cane as you again pass the strand down through the same hole. This method is continued around the entire border of the seat. If you find it difficult to pass the strand through some of the holes, you can enlarge the opening by working a nail around in the hole. If the seat, after it has dried thoroughly, rings when struck sharply by the hand, you have done a good job. A coat of clear varnish or lacquer on the cane will make it impervious to moisture and ready for a long period of usage.

C[A cane chair seat that sags can be shrunk taut by sponging it top and bottom with a hot

solution of vinegar and water.

RECIPE FILE

PATTERNED after the old-fashioned spice chest, this little cabinet features a drop front which opens to expose a handy recipe file. The front forms the bottom of the card compartment, which is pivoted at the lower end by two screws. The drawing shows how the parts go together. Note that the card compartment is slanted at the rear to counterbalance it when closed. Slant the saw cuts in the sides about 5 deg.



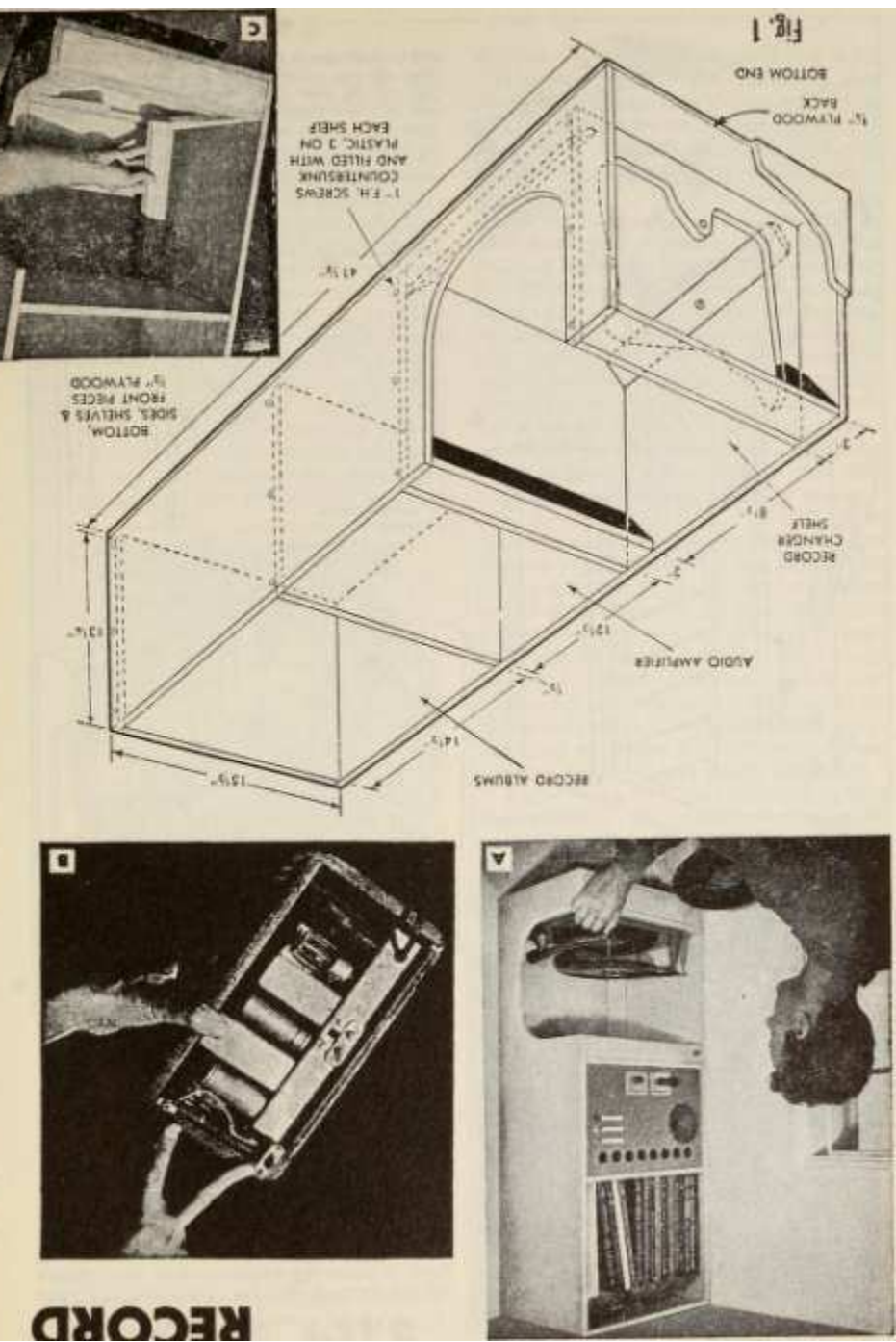
RECORD

1/4" PLYWOOD BACK

BOTTOM END

CABINET AND SOUND SYSTEM

IT AVE YOU ever wished that your home ■*■*■* were equipped with a super sound system that would enable you to play quality records or radio in almost every room? Such an arrangement would be ideal for the housewife as she moved from room to room to do her household chores or for anyone else in the family who had work to do in a certain part of the house. There is really nothing to installing such a system in a simple space-saving wall or closet cabinet that almost anyone could build, and the cost would depend on what you would like to spend for equipment. Separate amplifier, record changer, radio tuner and speaker units are available from radio parts houses. Any serviceman can



arrange a simple control panel like the one shown in photo E so that either the records or radio can be played through speakers located in various rooms.

Photo A shows a simple plywood wall cabinet that you can easily make. All dimensions and construction details are given in Fig. 1 and photos C, F and H.

Two strips of $\frac{1}{2}$ -in. plywood are fitted in the corners where the wires are to run up from the changer to the amplifier D and control panel E. The builder can use any available record player or a tape-disk type of recorder and playback unit such as the one illustrated in photo E. In this case, however, the cabinet would have to be wider as this unit measures $12\frac{1}{4}$ x 17 $\frac{1}{2}$ in.

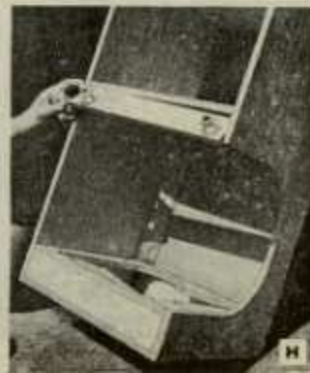
Two small 7-watt lamps mounted on the 2-in. strip as in photo H illuminate the record changer. Instead of a radio tuner, install a plug and switch on a small radio (photo B), and run a shielded wire from the set to a plug and jack on the amplifier control panel. Remote speakers can be located in wall cabinets like that in photo G.

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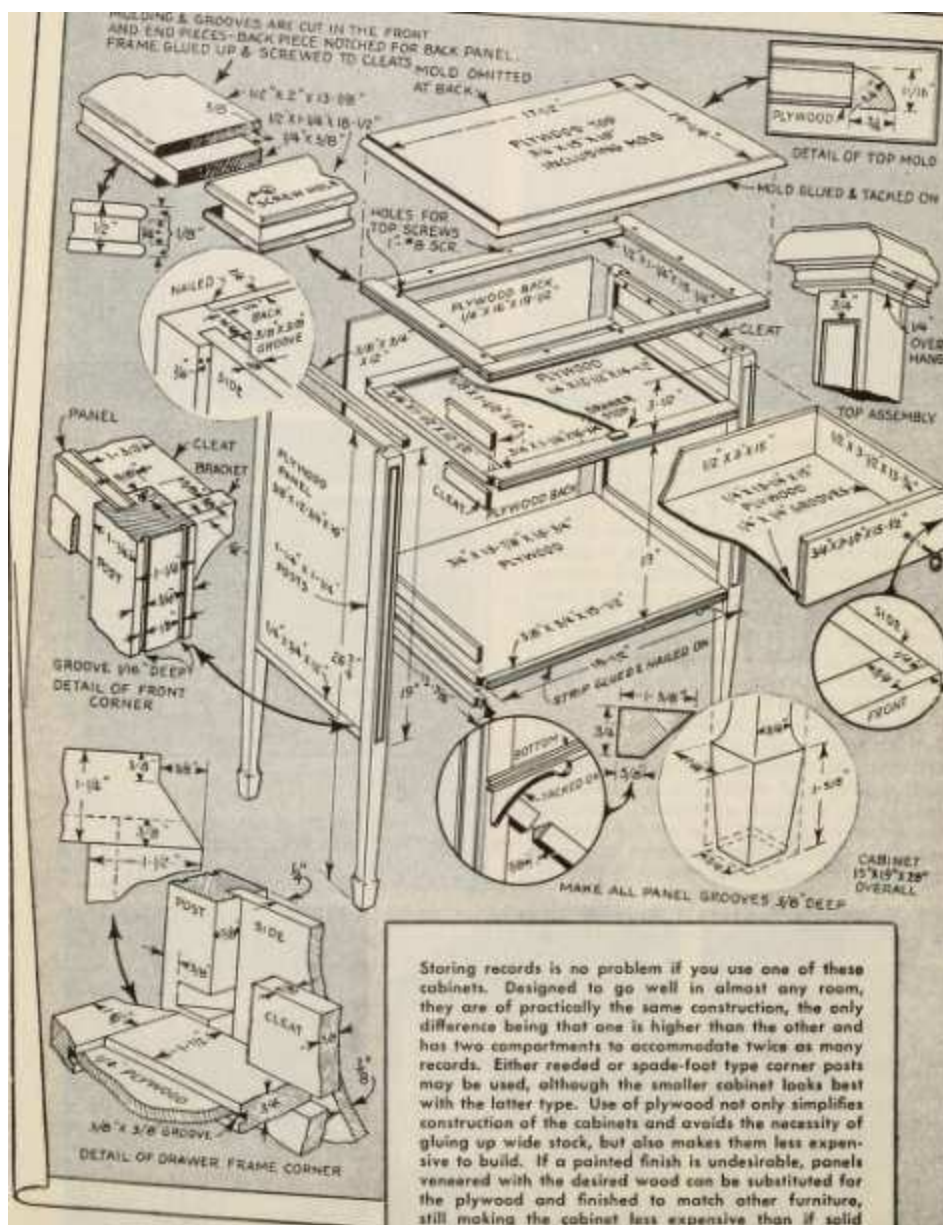
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RECORD CABINETS



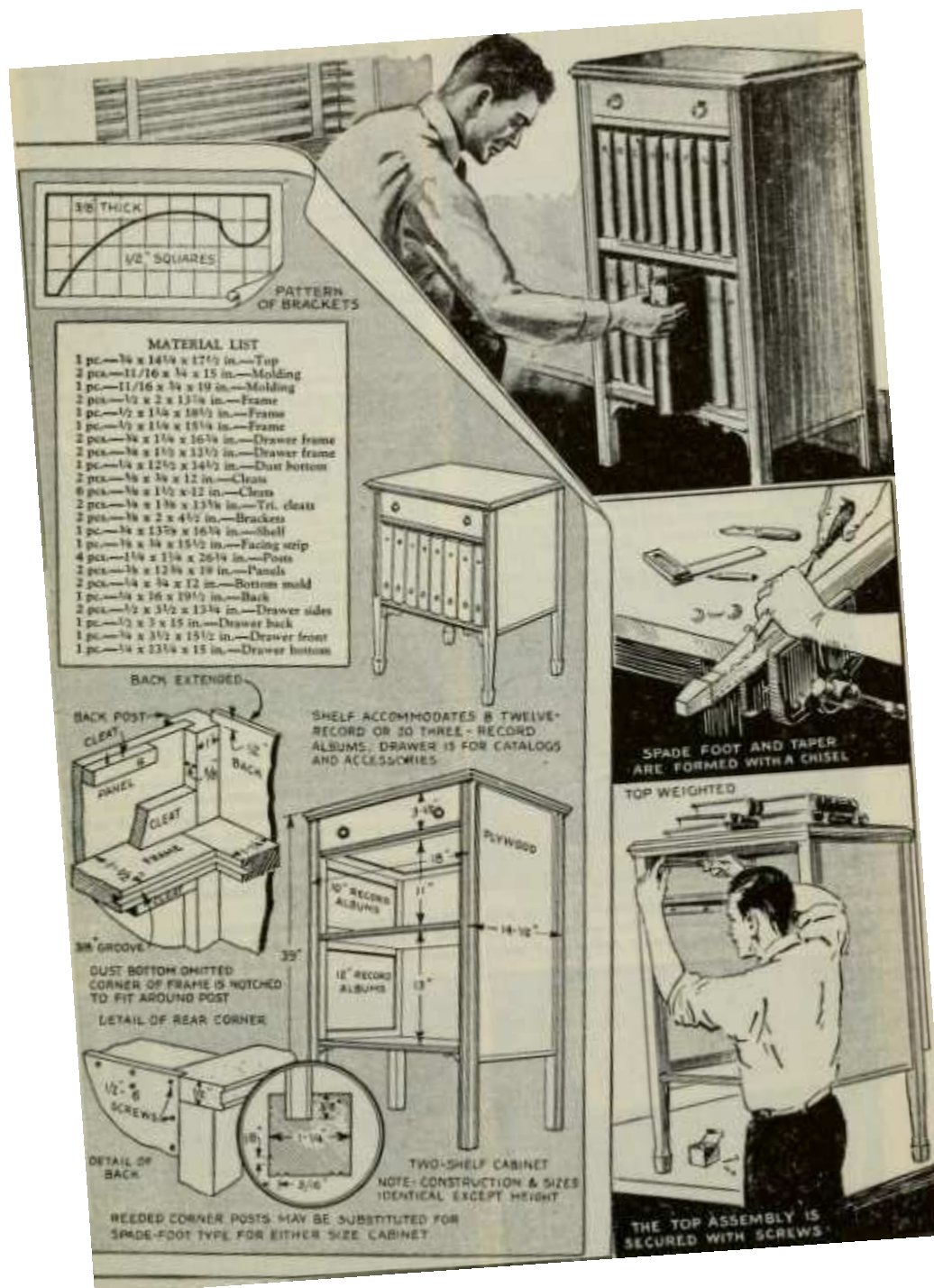
Storing records is no problem if you use one of these cabinets. Designed to go well in almost any room, they are of practically the same construction, the only difference being that one is higher than the other and has two compartments to accommodate twice as many records. Either reeded or spade-foot type corner posts may be used, although the smaller cabinet looks best with the latter type. Use of plywood not only simplifies construction of the cabinets and avoids the necessity of gluing up wide stock, but also makes them less expensive to build. If a painted finish is undesirable, panels veneered with the desired wood can be substituted for the plywood and finished to match other furniture, still making the cabinet less expensive than if solid

S -S/e DEEP

CAB/NET IS"ill9"X28"

OVERALL

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THE TOP ASSEMBLY IS SECURED WITH SCREWS



Set in front of phonograph, above, cabinet provides comfortable seat for changing records.

Below, furniture glides raise cabinet to facilitate opening door



Panel joints are glued and fastened in place with countersunk screws, below. Pilot holes drilled in end grain will prevent possible splitting of panel

RECORD CABINET

serves as hassock

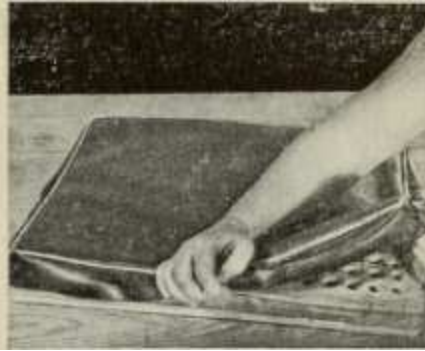
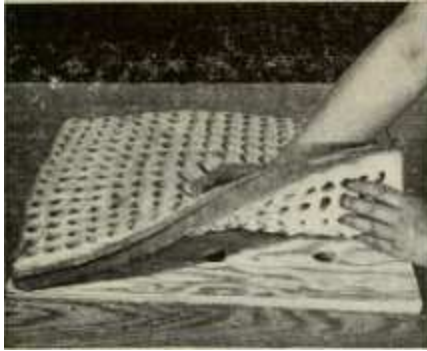
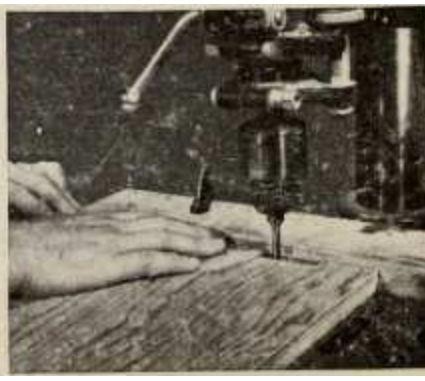
A few years, a phonograph-record collection invariably overflow., all available storage space which, in many cases, poses the problem of adding a record cabinet to a room already crowded with furniture. If this is the situation in your home, here is a combination hassock-record cabinet that not only will take care of the overflow of records but will double as a comfortable seat; The cabinet is partitioned into three sections, one for storing 10 or 12-in. record albums and two drawers for filing 7-in. records and miscellaneous items.

The sides, bottom and top of the cabinet are of $\frac{1}{2}$ -in. plywood and countersunk screws and glue are used to fasten all the joints. A recess must be routed or cut into the front edge of the right-hand side panel to permit mounting a friction catch for the cabinet door. A plywood partition then is set up between the top and bottom panels and a plywood shelf for the upper drawer is nailed to cleats attached to the side panel and partition. The shelf cleats are cut $\frac{1}{4}$ in. shorter than the shelf itself so the face of the lower drawer will fit flush with that of the top drawer.

The cabinet door is simply a $\frac{1}{2}$ -in. plywood panel that is hinged with invisible hinges. If the latter are not available, ordinary butt hinges can be used with satisfactory results. However, these also should be set in mortises so that the hinge leaves are flush with the wood surfaces.

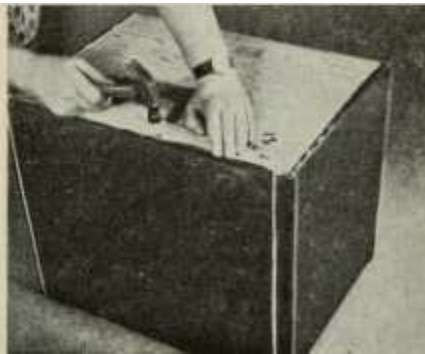
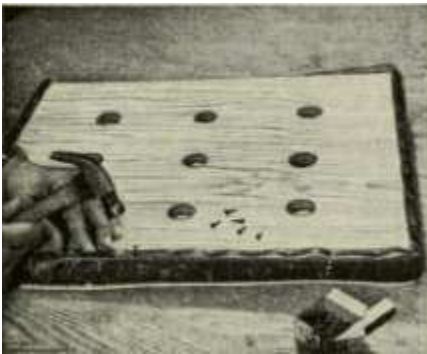
Plastic or imitation leather is used to up-

Photo below shows router bit being used to cut mortise in cabinet door. Matching mortises in door and edge of side panel receive invisible-hinge plates



A plywood base slightly larger than over-all dimensions of cabinet top is fitted with foam-rubber pad to provide seat cushion. Note ventholes in plywood

Cover for seat cushion is sewed together and placed over pad, above. Upholstery is brought around sides of cabinet and tacked to the top and bottom, below

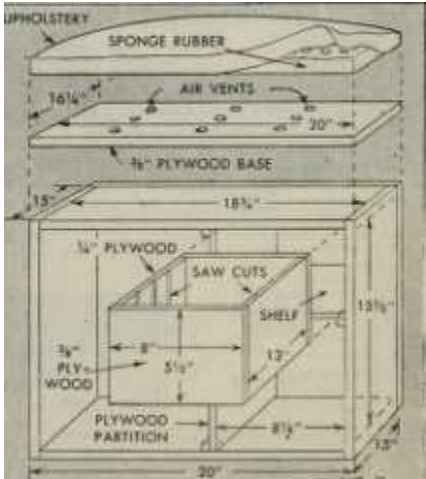


Seat-cushion cover is tacked to underside of plywood base and, after assembly, cushion is mounted on cabinet with countersunk screws driven from underside

holster the cabinet, which is trimmed with a decorative welt seam of a contrasting color. The welt is sewed between the upholstery panels and corner strips when covering the sides, and between the top panel and boxing, or edge strips, when covering the cushion. The latter consists of a plywood base, a foam-rubber pad and the upholstery, which is brought around the edges of the base and tacked to the underside. A neater job of upholstering can be done around the door opening and on the door itself if the exposed edges of the material are glued to the wood between the tacks.

The drawers are made as in the detail, the drawer bottom being nailed in rabbets cut along the lower edges of the sides, front and back. Dimensions of both drawers are the

same except that the face of the bottom one is made high enough to reach the lower edge of the top drawer. Furniture glides attached to the corners of the cabinet, raise it off the floor sufficiently to permit opening the door without binding.



BACK PANEL AND FRONT-DOOR

PANEL, 15!"s"X20" <■ ' ^

DRAWER BOTTOM NAILED INTO RABBETS IN DRAWER FRAME



RECORD CHANGER INSTALLATION



"VTOBODY wants to discard a good phono-•^ ^ radio console because it has a single-speed record player. Especially not when you can easily modernize it yourself so that it will play all speeds and record sizes automatically. Along with standard 78-r.p.m. records, 45 and SSVa-r.p.m. speeds have taken such a firm hold on music lovers that single-speed record changers are now seldom found in the new consoles.

With a few common tools and a modern three-speed mechanism, you can equip your set to play any speed or size of record available.

Owing to the wide variety of older phono-radio consoles, the installation of a new three-speed changer replacement should be planned carefully with three considerations in mind: Selecting the right changer, mounting the changer, and making the electrical connections. With rare exceptions, single-speed changers in phono-radio combinations employ crystal pickups, and the amplifier circuits are built to conform to their requirements. Therefore, it is necessary to replace a crystal-pickup single-speed changer with a three-speed changer also equipped with a crystal pickup. An exception to this general rule, the variable-reluctance pickup. Fig. 2, will be discussed later. Photo G shows a typical crystal pickup mounted in the tone arm of a single-speed changer. If your pickup is a crystal type it will look very much like this one. A typical three-speed record changer is shown in photo B; this is the Webster-Chicago Model 101 replacement, or conversion type which is available from practically any radio-parts house.

CHANGER

COMPARTMENT

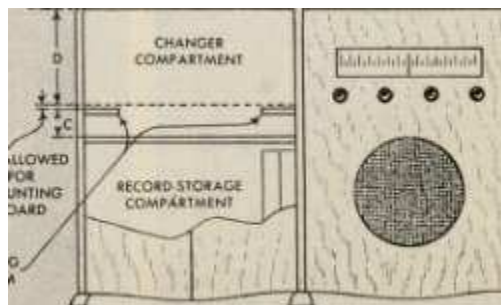
OF SET

% " ALLOWED

FOR MOUNTING *J BOARD

MOUNTING ^ PLATFORM

FigJ



It is obvious that the size of any changer you select for installation is of extreme importance. Carefully measure the dimensions of the changer compartment in your console, noting the inside length and width of the space available, and also the height above and below the mounting platform. In measuring the height above, subtract ¹/₈-in. for the thickness of the mounting board. Make a copy of Fig. 1, inserting inside dimensions A, B, C and D; measure the dimensions to at least ¹/₁₆-in. accuracy.

Space measurements must be made with accuracy regardless of the way in which the old changer is installed. Some are mounted to expose the changer when the top of the cabinet is opened, as in photo D. Others are built into a slide-drawer assembly which pulls out with one of the front doors, or panels. Still others are mounted on a hinged bracket so that the changer comes forward when the door is opened. In this last case it is often desirable to remove the entire changer with its special bracket and, with the aid of slide-drawer hardware, to install the new changer as a drawer assembly. Some manufacturers of replacement units supply a slide-drawer hardware assembly to be used with a mounting board.

Be sure to discuss with your dealer the important subject of 12-in.-record overlap. Most three-speed changers either are less than 12-in. across, or the record spindle is not geometrically centered. This means that while 7 and 10-in. records do not extend beyond the changer edge, there is often an overlap with a 12-in. record. This overlap must be taken into consideration in your particular compartment measurements.

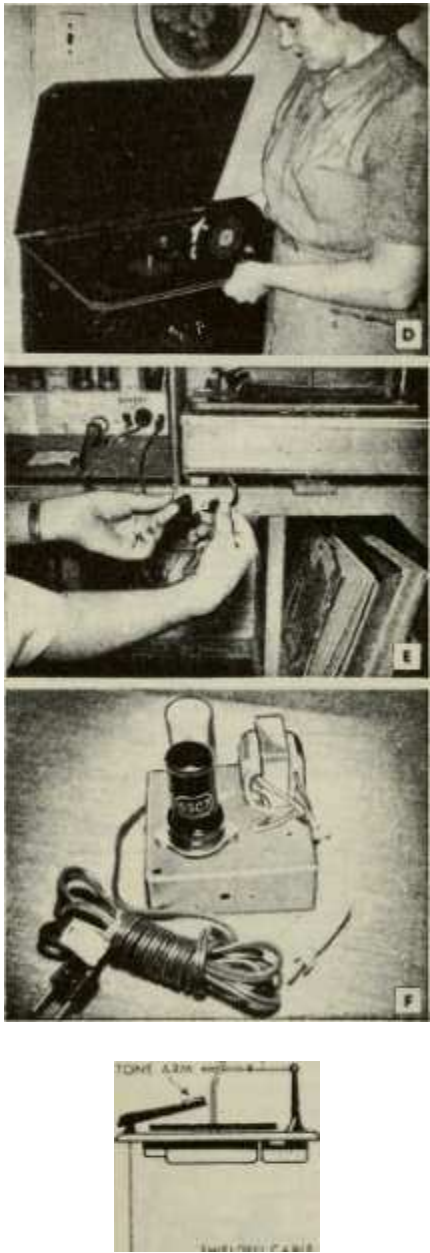
To remove your old changer, first disconnect the set from the power-line wall receptacle.

Locate the bolts holding the changer

$V_c < K_i A B L E R i i l U C T A N C E . \bullet '$

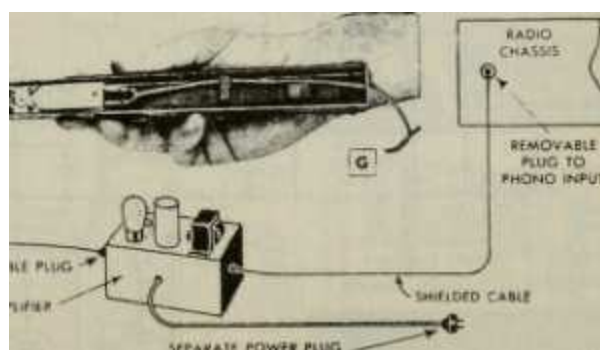
$H_f . A O \text{ ON } ^\wedge$

$TONE \text{ ASM } \blacksquare = / U ^ \wedge ^ \wedge$



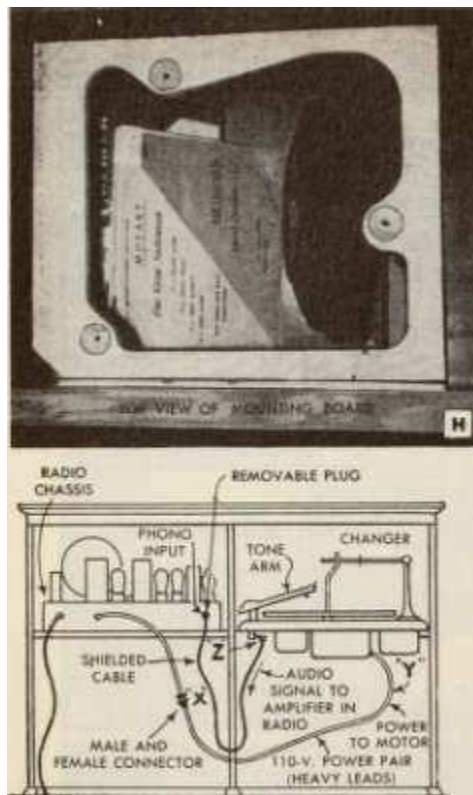
SHIELDING CABLE

Fig. 2



REMOVABLE PLUG -Pftt AMPlflfc?.

bEPAKATE POWER PLUG FOR I 10 V RECEPTACLE



on the mounting platform; in a drawer-assembly mounting, the drawer must be unlocked from the rear so that you can pull it far enough forward to work with. This generally can be done by removing one or two wood screws which fasten the retaining clamp to the inside of the cabinet. The nuts in most cases can be reached from the record-storage compartment. Do not lift out the changer until the electrical connections have been disengaged as indicated in photos C and E. There are two sets of these electrical leads which must be disconnected. One is the 110-volt a.c. pair shown at "X" in Fig. 3; the other looks like a single conductor but is really a pair with an outside shielded metal cable enclosing an inner conductor. The shielding is often covered by black or brown cotton fabric. This terminates in the removable phono pin plug shown in the inset photo I in the schematic diagram of the circuits involved in a three-speed-changer installation (Fig. 5). This

AAAIN POWER CORD AND PLUG

FOR WALL RECEPTACLE (LEAVE INTACT)

FIG. 3

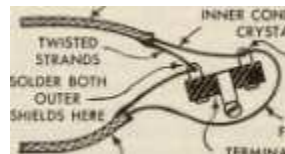
SHIELDED CABLE FROM CRYSTAL PICKUP INNER CONDUCTOR FROM CRYSTAL PICKUP

SOLDER BOTH

INNER CONDUCTORS

HERE

INNER CONDUCTOR FROM RADIO CHASSIS TERMINAL STRIP BELOW CHANGER
FIG 4



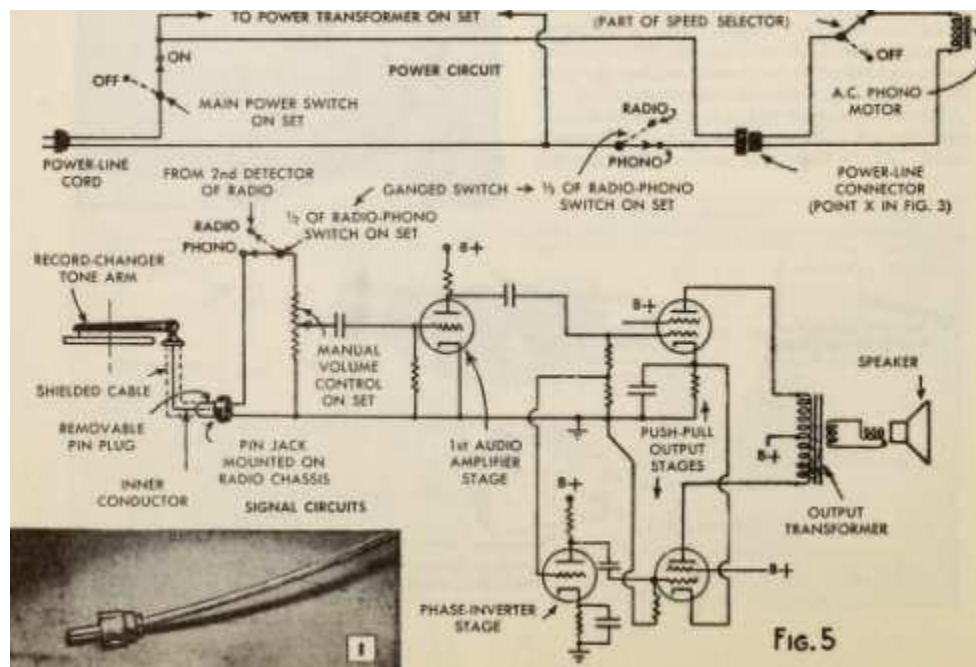
SHIELDED CABLE FROM RADIO CHASSIS

TO POWER TRANSFORMER ON SET

PHONO SWITCH ON CHANGER (PART OF SPEED SELECTOR)

POWER CIRCUIT

MAIN POWER SWITCH ON SET



cable carries the audio signal from the changer to the amplifier circuits in the receiver chassis. If your old set previously used a single-speed changer with crystal pickup, no circuit changes need be made under the radio chassis. If your new changer is not equipped with a power cord, do not pull connector "X" apart, but instead clip both power leads at point "Y" about 2 in. below their connections to the old changer. The long leads will later be used to deliver power to the new changer.

If your new changer is already equipped with a shielded cable and pin plug, pull the old pin plug from the pin jack on the radio chassis and use the new shielded cable. If the new changer has no shielded cable installed, unsolder the shielded cable from the old changer at point "Z" shown in Fig. 3. This same cable will be used later to bring the audio signal from the new changer to the radio-set chassis. Now you can lift out the old changer. If no mounting board comes with the new changer, the manufacturer supplies a template with full directions for cutting and drilling the $\frac{1}{8}$ -in.-plywood mounting board to conform to the shape of the new changer. A top view of a typical mounting board, in position in the changer compartment, appears in photo H.

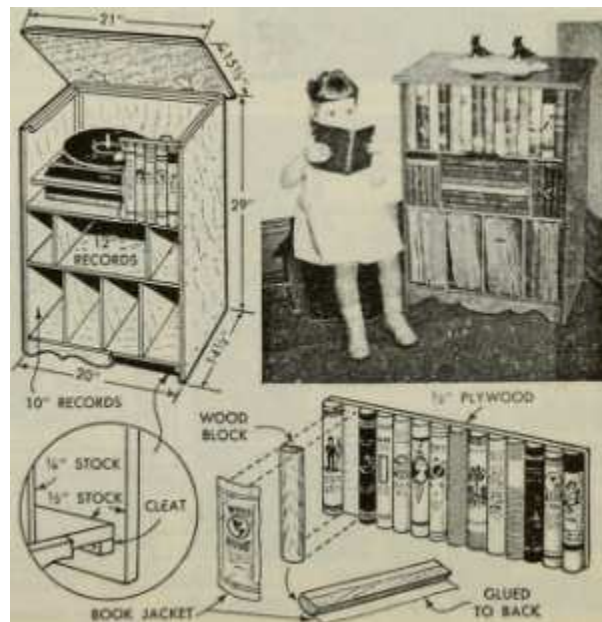
Sand, stain and varnish the mounting board before fastening it down permanently. Your new changer will be shock-mount-

ed on springs or rubber bushings. The method of rewiring the electrical leads to the new changer will be determined by whether or not it is already provided with cords and plugs attached. If it is, drop these leads through the large opening in the mounting board as you set the changer in position. If the new changer is not provided with attached leads and plugs, use the old leads and connectors as previously stated. The shielded cable from the radio chassis to the pickup arm will be connected to a terminal strip that the manufacturer provides underneath the main plate of the changer. This terminal strip and the necessary connections are clearly shown in Fig. 4. Note that the metal shields are connected together on one lug and the inner conductors on the other. On the initial test, if a loud hum is present, it may be eliminated by reversing the power leads to the changer only. You should never plug an a.c. record changer into a receptacle wired for d.c. If a variable-reluctance pickup is desired, instead of a crystal, the changer will be installed as described but a preamplifier must be added as indicated in Fig. 2. A self-powered G.E. preamplifier designed for this purpose is shown in photo F. These are available from all radio-parts houses, and they are easily installed in the audio lead between the changer and radio-set chassis.

Built of plywood and partitioned to meet individual requirements, this unusual cabinet provides compact storage space for both loose records and albums in addition to housing a portable record player. The front panel of the record-player compartment is faced with brightly colored book jackets. These jackets are glued separately to a number of wooden blocks which are rounded on one face and fastened side by side to the panel. If the phonograph is to be played through a table radio, the partitioning of the cabinet can be varied so that the radio will fit in the center compartment. A piece of plywood which is cut

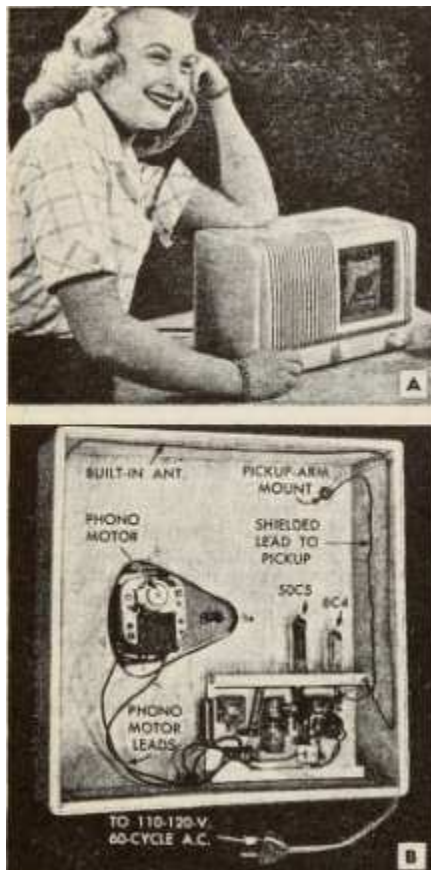
to fit over the top of the record player provides a shelf for accessories and needle cups which are recessed flush.

Record-Player Cabinet Simulates Bookcase



BOOK JACKET

GLUED TO BACK



RECORD PLAYER

THIS HIGH-QUALITY "wireless" record player, employing a special oscillator circuit, can play phonograph records without the necessity of a direct connection to the radio set itself, as illustrated in photos A and D.

With the short built-in antenna indicated in photo B, broadcasts can be made up to 10 ft. with plenty of signal strength, and up to 20 ft. with acceptable signal strength. With the addition of about 20 ft. of external wire added to the built-in antenna, a range of from 20 to 30 ft. can be covered easily. The two-tube oscillator unit and three-speed record player operate from any 110-120-volt, 60-cycle a.c. line. Photos B, C, D and E show various views of the completed unit which is housed in the homemade case detailed in Fig. 2. The schematic circuit diagram appears in Fig. 1. The chassis base is standard miniature open-end aluminum type that is mounted in one corner of the plywood case by means of two 6-32 ornamental-head machine screws, 1 in. long, in the position shown in photo F. The size of the cutout for mounting the phono motor in the cabinet, - Fig. 2, will depend upon the make of the three-speed phono motor used. The selenium rectifier for the oscillator unit can be either a Mallory 6S75 or a Federal No. 1003A, the latter being preferred for this particular circuit. A 6C4 amplifier tube is used to modulate one of the grids of a 50C5 oscillator tube. A standard Meissner oscillator coil, No. 14-1040, is employed.

SHIELDED LEAD FROM PICKUP

ANTENNA TACKED AROUND INSIDE OF BOX

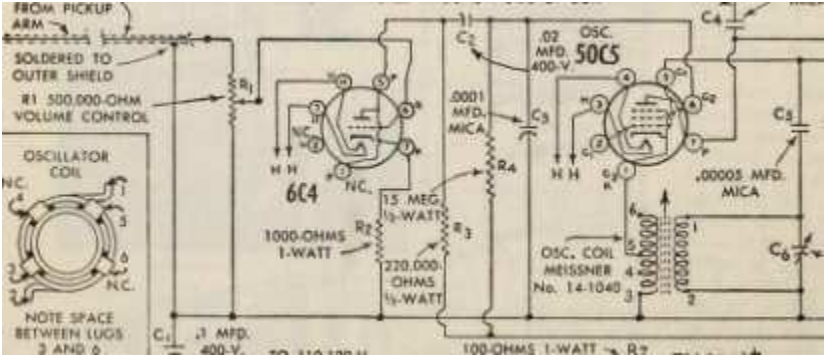
^.

.000025 MFD. ^ MICA

NOTE SPACE

BETWEEN LUGS

3 AND 6



2 Vj MH. R.F. CHOKE

ri: 33,000-OHMS Vi-WATT " ^

70-480 MMFD. TRIMMER COND.

:Rs

GND. ON -/-i-CHASSIS

Fig. I

TO 110120.V. 60-CYCLE A.C. LINE

SWITCH ON

1000HMS 1-WATT

-^Ot-W-W^

tE

R6

Pt

VOLUME CONTROL

110120-V. LEADS TO PHONO MOTOR

f » ->_ ^v^ ^ ^ ^v *■ V ^ \i

I / 10 WATTS H H |H H

•^ I 1 ^ \ SELENIU • f^ 1~ \ MALK

1

M RECTIFIER MALLORY 6S75

\

10.0000HMS C8_1+ 1-WATT

DUAL 20.MFO. ISO V. ELECT.

^

TUBE HEATERS CONNECTED IN SERIES

NOT£-N,C = NO CONNECTION

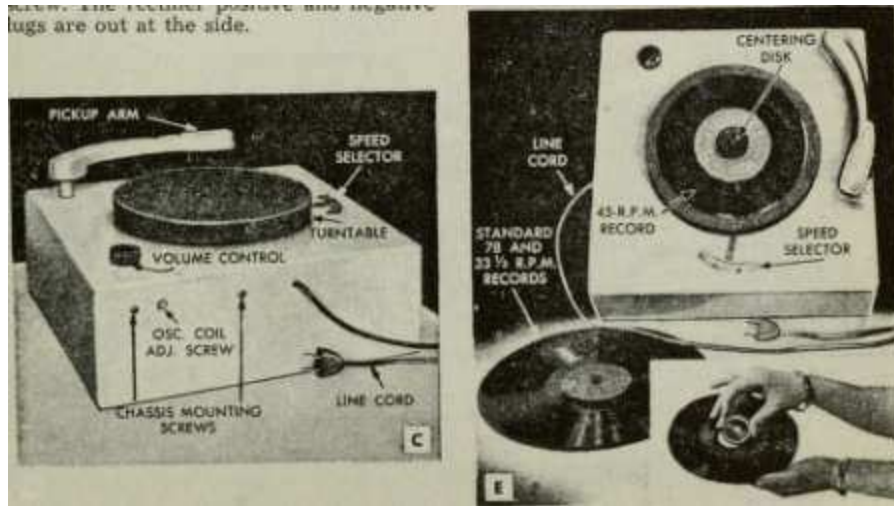
TUBE SOCKETS BOTTOM VIEW

(Lugs 3 and 6 are wide-spaced for terminal identification. See Fig. 1.) The 6C4 tube amplifies the weak signals from the crystal pickup. The three-speed phonograph turntable plays any standard 78-r.p.m. record, also the popular 33V3-r.p.m. long-playing records, and 45-r.p.m. miniature records. The pickup uses a universal stylus having a .002-in.-dia. point so that it may be used with any type record without changing needles. It is the Shure model 901U.

The actual layout of parts on the oscillator chassis, photo F, is not critical. The volume control R1, which includes the on-off switch, has its shaft protruding through the top of the plywood case. A hole is also provided on the side of the case to permit the adjustment of the oscillator-coil tuning-slug screw. The tube-socket holes in the side of the chassis base are $\frac{1}{8}$ in. in diameter and may be made with either a tapered reamer or a $\frac{1}{8}$ -in. socket punch.

The power-line leads for the phono motor and line cord are connected to a terminal strip which has three insulated lugs. Looking at photo F, the line cord connects to the center and left-hand terminals. One of the phono-motor leads also connects to the left-hand terminal. The other one is on the right-hand terminal. The center and right-hand terminals are connected to the switch on volume control R1. Leads to R7 and R8 are also connected to the right-hand terminal. The two final connections on the left-hand terminal are the end of condenser C1 and a lead run over to common ground on the insulated two-lug terminal strip at the left of the volume control. The opposite end of C1 goes to chassis ground on the top of the selenium-rectifier chassis-mounting screw. The rectifier positive and negative lugs are out at the side.

The oscillator is tuned both by means of the small mica trimmer condenser C6, and the iron-core slug inside the oscillator coil. Tune in your home radio set to a spot on the dial where no broadcast stations are received. Go back to the record-broadcaster unit and adjust the trimmer condenser C6 with a small screwdriver to where you hear a quiet spot without crackling or hissing in your radio. You will identify the presence of your record-broadcaster carrier signal when these noises stop. Now put a record on the turntable and set it to playing. Following this, for precise adjustment to the exact frequency on your radio set, adjust the oscillator-coil screw until maximum volume and clarity are obtained. The volume control R1 permits setting at the proper playing level for the various kinds of rec-



ords. See that the speed selector is set at the proper speed for the type of record you are playing. The proper setting of the volume control is the highest setting which does not

FOR VOL. CONT

Vi" ARM-MCi'VTING

HOLE " (SEE TEXT)

"K^v. HOLE FOR

13" ARMPEST

3iVi"-->

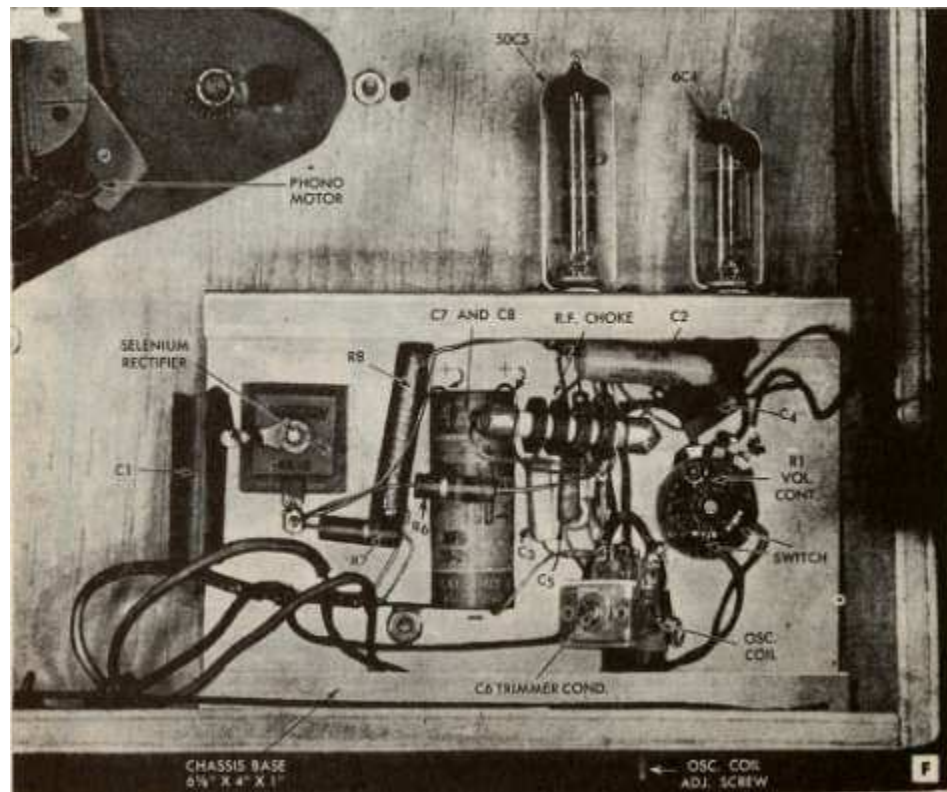
> ^- 'CC>%>^ CUTOUT -"*^ >^for PHONO MOTOIJ >^ (SEE TEXT)

introduce distortion. It is always better to advance the volume control on the radio receiver rather than the volume control on the record broadcaster in order to prevent distortion. Too high a volume-control setting in the phono-oscillator unit will result in impaired reproduction quality. This unit is not designed for use with a microphone. It is intended for record-playing purposes only. But it will allow you to play phonograph records through your radio receiver with greatly improved quality of reproduction. This is made possible by the nearly 100-percent modulation from the amplifier tube, a feature definitely not found in phono oscillators of the past.

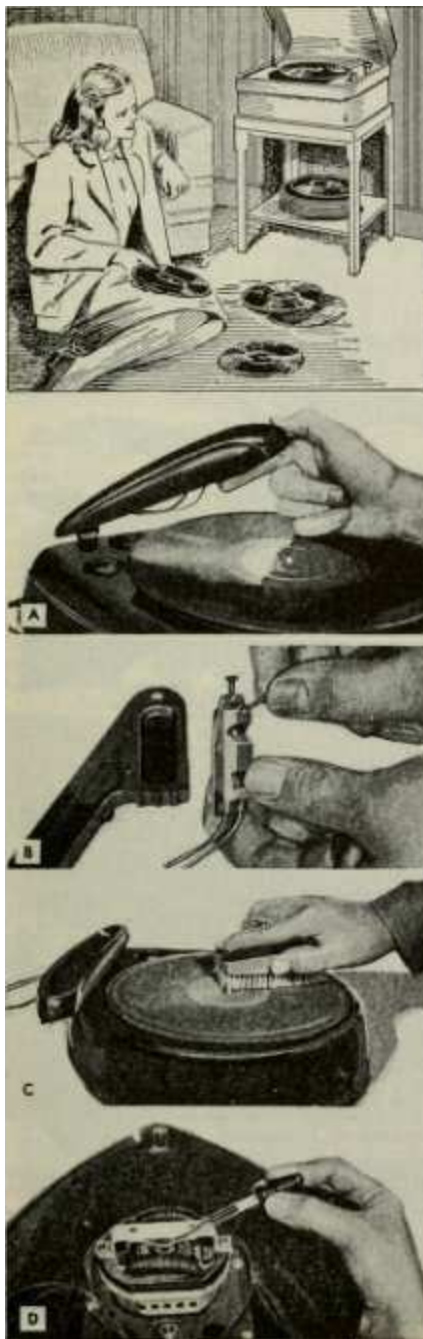
DETAIL OF CASE

ROUNDED CORNERS-

5/8" PLYWOOD



RECORD PLAYER SERVICING



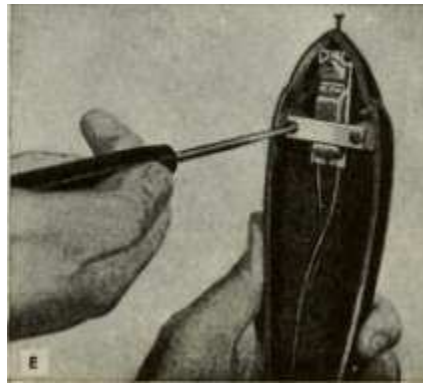
ALTHOUGH usually built to withstand [^]*- rough handling, your record player, like any other precision instrument, must have occasional attention if maximum service is to be maintained. Separate record players designed to play through the audio stages of your regular broadcast receiver require more attention than those built into combination phono-radio consoles or table-top cabinets. However, the following service hints apply to all types.

When the wires under the pickup arm leading to the crystal cartridge become loose, as illustrated in photo A, they will drag on the record and cause noise. In the case of a separate record player, the bottom plate may be removed and the slack pulled out, after which the wires may be secured with a piece of adhesive tape. In combination phono-radio sets these wires may be reached, in most cases, from the rear of the cabinet.

If the record player does not operate, the pickup cartridge may be defective. Check the cartridge by grasping the needle as shown in photo B; if the needle holder may be moved

back and forth to any extent, it usually means that the pickup has been damaged and a new cartridge is necessary.

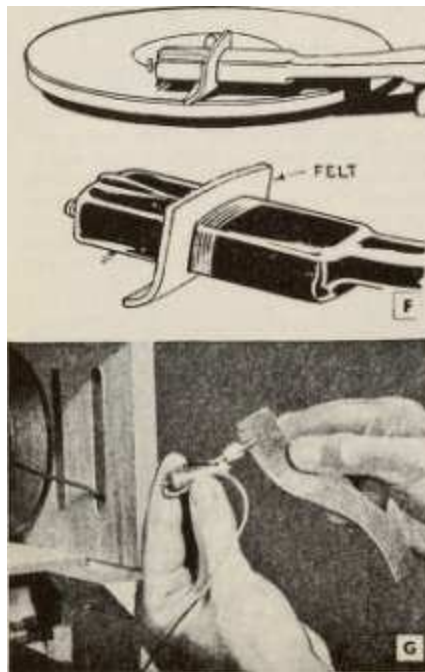
Dust particles scratch records on the side in contact with the cloth covering on top of the turntable. A small brush should be used at regular intervals as indicated in photo C. The bearing of phonograph turntables in constant use may require an occasional oiling. Where the motor has a felt packing as in photo D apply a light application of oil with an eyedropper; in some motors it may be necessary to use a drop of oil on a wire to reach the bearing. Crystal pickups are fragile and should be kept tightened in their arm mounting bracket as illustrated in photo E.



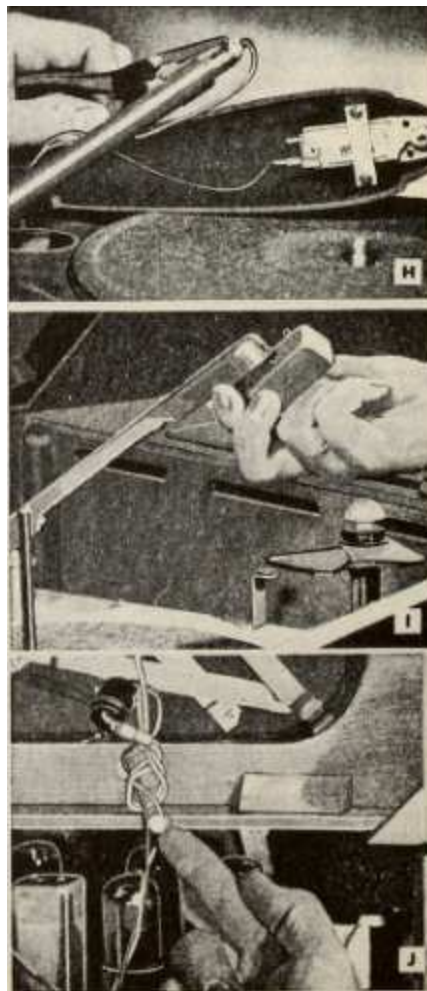
HOW TO CARE FOR YOUR RECORD PLAYER

Pickup arms vary in shape; a common type is illustrated in sketch F. With an arm of this general shape it is an easy matter to make a dust collector by slipping a piece of soft felt over the end of the arm as shown; this acts as an automatic wiper. It sweeps the record as it revolves and holds back some of the dust particles that would otherwise pile up around the tip of the needle and reduce the quality of reproduction. Cut the opening in the felt slightly under-size so that it will stay in place on the pickup arm. There should be enough material under the arm so that it will bend forward as it contacts the surface of the record, as indicated in the sketch.

Noise in radio-phonograph combinations, and also in separate record players that are plugged into phono-input jacks in radios, is often the result of an oxidized phono plug that needs cleaning. To clean the plug, use a piece of light emery cloth in the manner shown in photo G; this will usually clear up the trouble. If it ever becomes necessary to replace a crystal pickup cartridge, never solder the leads directly to the cartridge terminals. The crystal cartridge is very fragile and easily damaged by the heat of a soldering iron. The leads should be sol-



dered to slip-on clips as illustrated in photo H. The clips are then easily pushed on the cartridge terminals by hand. More phono needles are damaged by dropping the pickup arm on the turntable or the cabinet accidentally than in any other way. A piece of art gum may be used as shown in photo I without damaging the needle. The block of art gum acts to keep the arm from sliding if it is removed from its rest and protects the needle if the arm drops off accidentally. Wires in combination record players often become entangled with the turntable gears if carelessly installed. Such wires may be held in place with a thumbtack, photo J.



!

Photo K —The shielded cable indicated, leading from the pickup to the input of the audio

amplifier, must be kept clear of all moving parts, but it must not hamper the pickup movement by placing a tension on the pickup arm. Keep this lead dressed, or secured, in its original position with either cellulose tape or rubber bands. If this shielded lead is broken or damaged in any manner it must be replaced with another of the same type and length, and the woven-wire shield should be grounded at the same points. Use a small soldering iron and apply it carefully using only just enough heat to make the rosin-core wire solder flow to form a good connection.

Photo L —Touching the finger to the needle as shown should produce a slight noise in the loudspeaker if all parts are in operating condition. This check is often helpful in phono-radio combinations for checking inoperation—particularly where the audio system may be tried by switching to "radio."

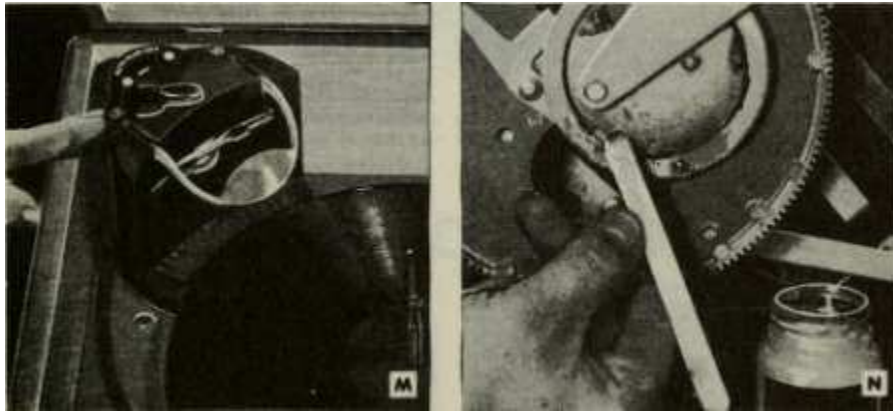
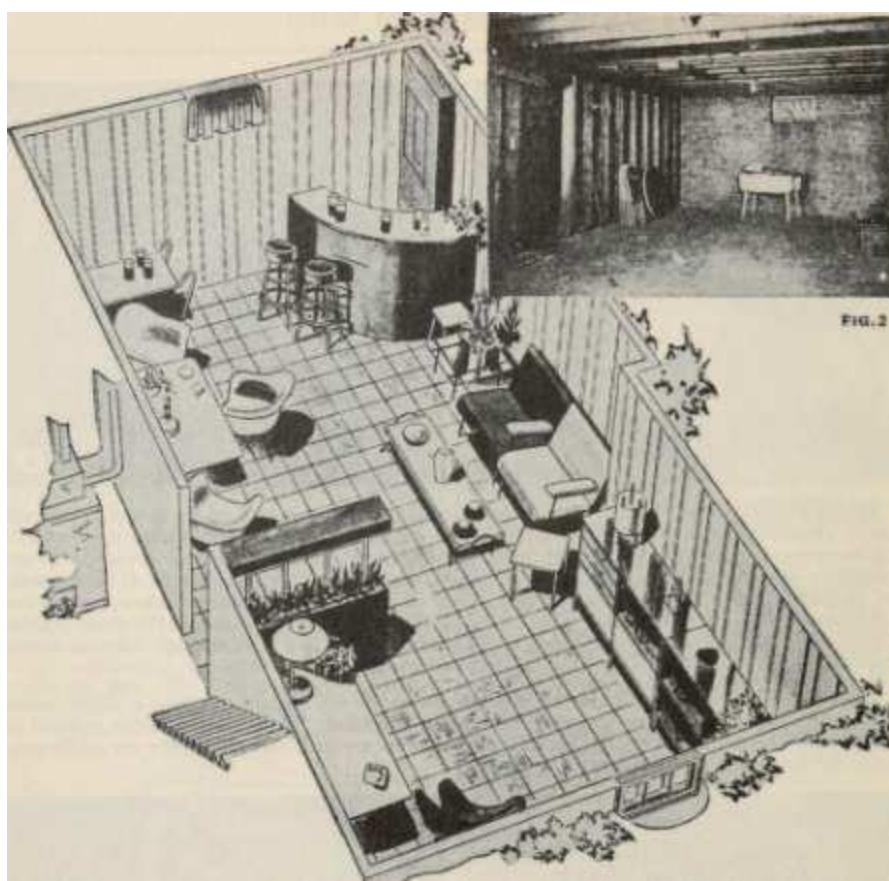


Photo M —This calls attention to the device used to adjust the player for the size of record to be played. If the needle does not land in the proper position on the record, check to see if it is set correctly for the size of records you wish to play. If you have a new automatic record changer and you are not familiar with its operation, do not touch the pickup arm while it is in cycle. First read the instruction sheet that the manufacturer supplies with the instrument, and you may avoid unnecessary service calls.

Photo N —Proper lubrication is important. Special lubricants are sold for the turntable and gears. Petroleum jelly may be applied sparingly to moving parts and gears when necessary as illustrated.



piQ J ^-notos courtesy Insulite Division, Minnesota & Ontario Paper Co.

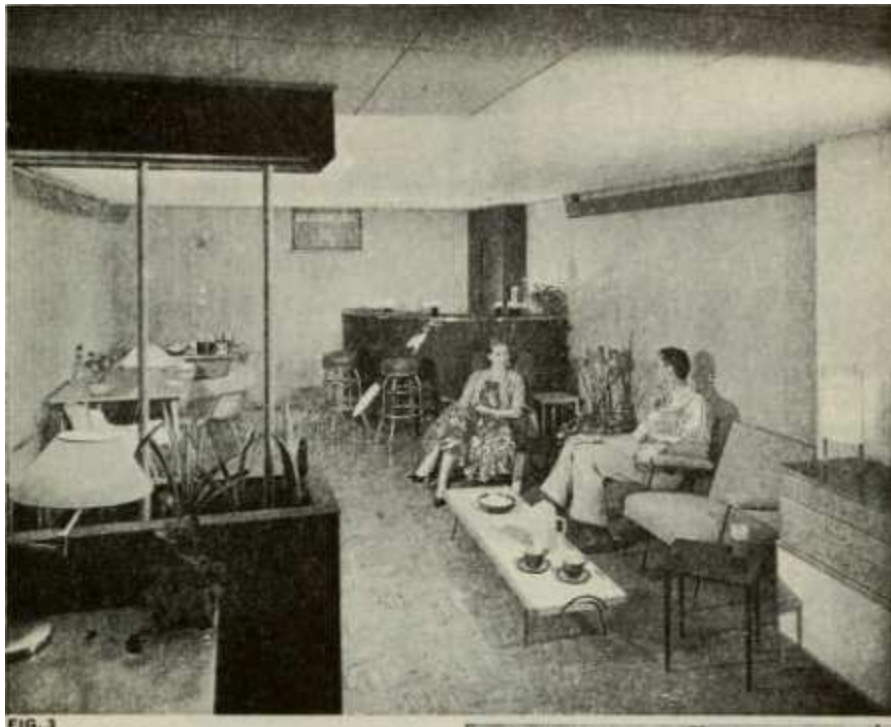
Roomy, basement rumpus room avoids lots of wear and tear upstairs. Building it yourself saves about half of the usual cost. For satisfactory results, first take steps to assure a dry basement the year round

RECREATION ROOMS

BASEMENT SPACE, often not utilized to its full advantage, frequently equals as much as 100 percent of the first-floor area. In growing families the basement is the ideal location for a rumpus or recreation room where hilarity is least likely to interfere with other members of the household. You can finish off only a portion, leaving the laundry area intact as it was originally. In many cases the heating plant and a workshop area can be completely concealed with partitions.

Examples of basement conversions: Fig. 1 shows a view of a finished basement room that occupied about half of a basement space. Before the conversion, one end appeared as shown in Fig. 2. Both ends of the room, after conversion, are shown in Figs. 3 and 4. Note the neat plank-type wall covering, the tile-effect ceiling, the tiled floor, corner refreshment counter, and the comfortable modern furniture. The half wall in the foreground, fitted with a plant box, divides the room into two centers of interest. The children's end of the room, where toys are stored and used, is shown in Fig. 4.

Before and after scenes of another base-



ment conversion, having a nautical motif, are shown in Figs. 5 to 8. Table tennis is a featured activity here as shown in Fig. 5. A home-movie screen is located above the window, and there's ample space for a workshop nook, Fig. 7. Laundry can be hung to dry in this room as shown in Fig. 8. Lighting is provided by flush-type ceiling fixtures.

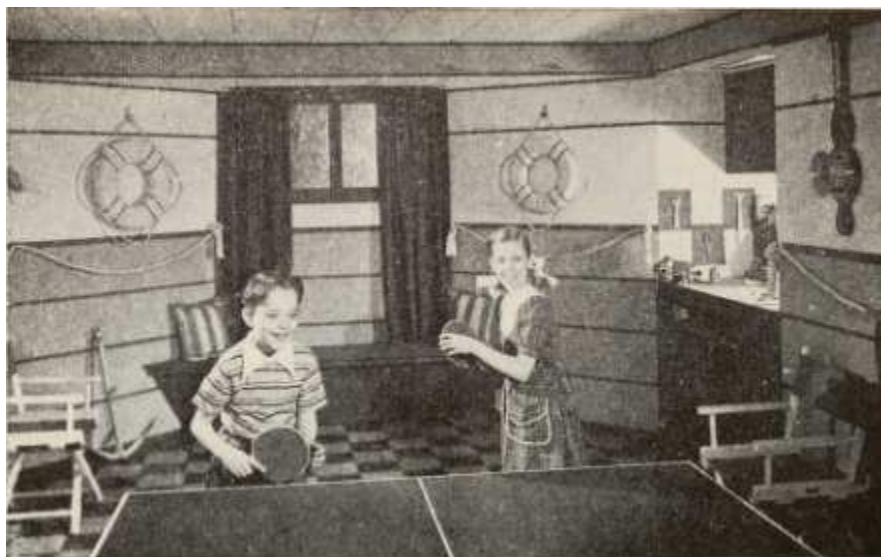
Another example of an outstanding basement conversion, where an attractive play room was built around a laundry, is shown in Fig. 9. How it looked before conversion is pictured in Fig. 10. The rumpus room has a radio, record player, television set, some inviting chairs, a double bench, card table, folding buffet table, recessed book cases, storage closets and wardrobe closets equipped with sliding doors. A wall heater was installed near one corner for use in extremely cold weather since the heating pipes were enclosed.

The laundry room is triangular in shape. The angular wall has set-back panels and counters on both sides. Beverages can be served through the upper parts of the two center panels. These are normally closed with hinges at the top. When opened, the doors are hooked to the ceiling. This provides a bar without making it a conspicu-



ous feature of the room. Fluorescent lighting behind opal glass was installed next to these doors in the set-back portions of the panels. Before and after pictures of the laundry are shown in Figs. 11 and 12.

Start with a dry basement: If your basement becomes damp during the summer months, or if water from outside of the house sometimes leaks into the basement, these faulty conditions should be remedied before you go to the trouble and expense



of building a recreation room or living quarters. Wet basements are a major problem in many localities, even though they may be perfectly dry part of the time.

Division of space: The first step in planning your basement rumpus room is to determine

how much of the space can be used for it, and where to install partitions to the greatest advantage. If a basement is large you will perhaps want to finish only part of



FIG. 2 Photo courtesy Wood Conversion Ed.

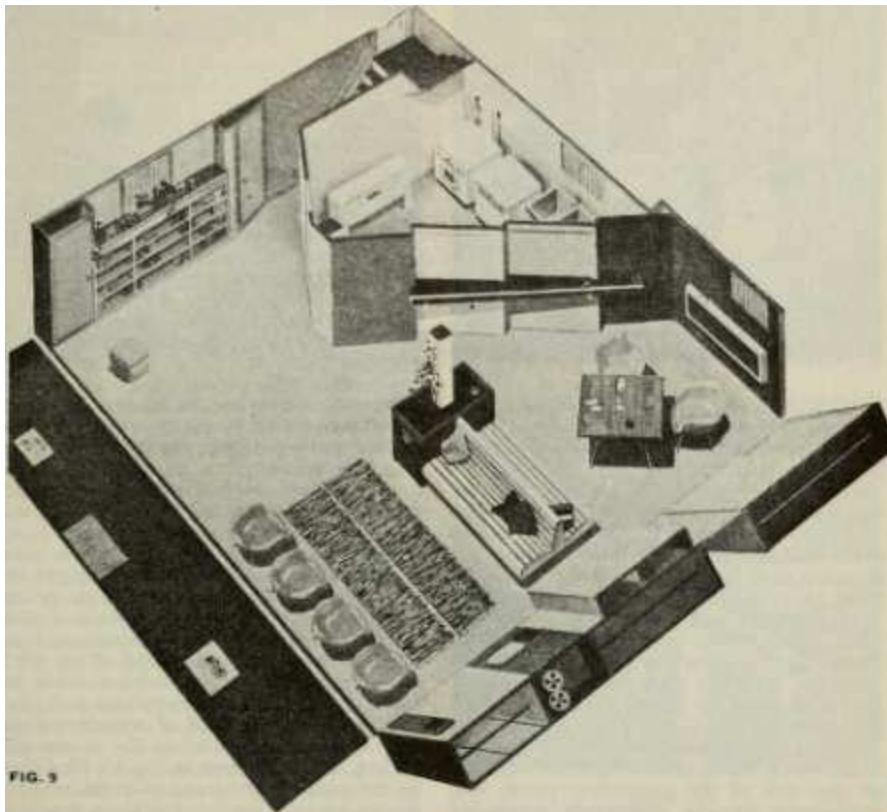
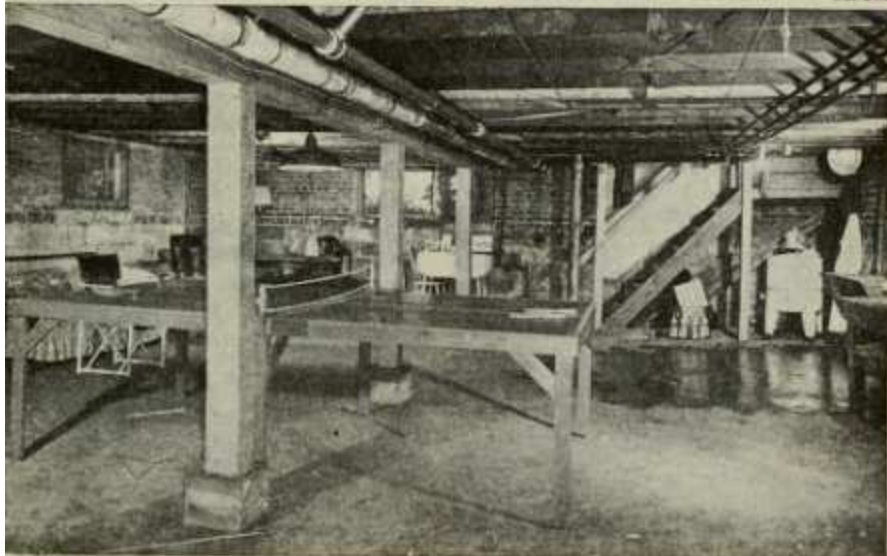
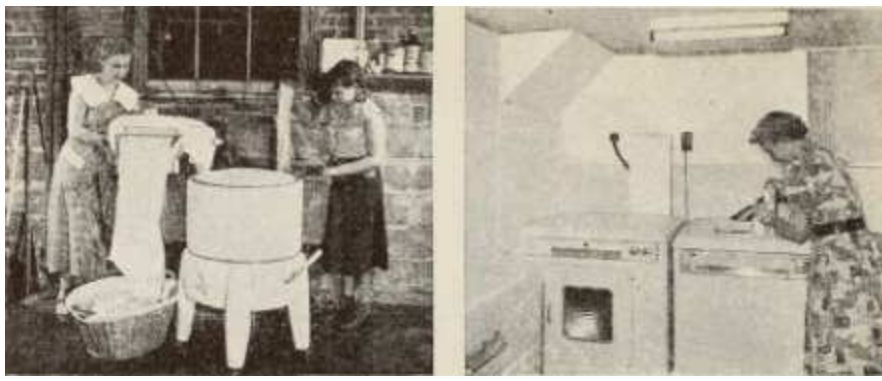


FIG. 3

BEFORE





it, thus avoiding too great an expenditure. Usually it is not advisable to move a heating plant, water heater or plumbing pipes serving a laundry, although this must be done in some cases. Therefore, you plan the location of partitions so that the heating plant and laundry will be concealed from the finished rumpus room. Where the laundry area juts out into the space to be used, you can still install partitions around it, making the recreation room L-shaped. One wall can even be arranged diagonally as in Fig. 9, making the laundry triangular in shape. You can dispense with the usual space required for hanging clothes, if you add a dryer to the laundry equipment.

In small basements where laundry equipment and a water heater must be included at one end of the recreation room, this equipment can be effectively concealed when not in use by means of cabinets. Before and after views of such a change are shown in Figs. 13 and 14. In this case the cabinets enclosing the water heater and laundry tubs can both be moved when necessary. The water-heater cabinet has extra storage space for small items as

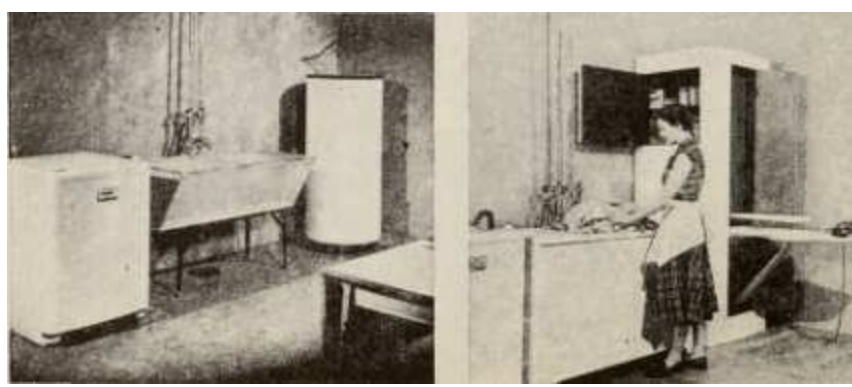
shown. Cabinets can be made easily from

hardboard nailed to a suitable framework.

Transposing pipes, conduit and wires:

Gas and water pipes, electrical cable or conduit, telephone and doorbell wires, may have to be transposed in order to obtain maximum neatness of your finished room. Many ceilings, particularly those in older basements, are so cluttered with pipes and electrical wiring that it would be practically impossible to cover the ceiling without first making extensive alterations. Such changes must be considered at an early stage in planning, and they are made before you start with the partitions and other framing. An example of interfering gas and water lines located in the center of a ceiling space is shown in Fig. 15. The pipes in this case were moved to come between the girder and the heating pipes shown in Fig. 16, so that all pipes could be enclosed in a single "boxing."

When such changes are made, remember that the hot and cold water-supply pipes should not be run closer to each other than 6 in. unless they are insulated. When boxed in with heating pipes, cold-water pipes



riitos ciiuilsy Masoiutji.Co),i).

should be insulated for two reasons: 1—It will prevent the absorption of heat from the heating pipes; 2—It prevents the cold-water pipes from sweating, which results in water stains on the ceiling. The insulation used for this purpose should be the anti-sweat variety.

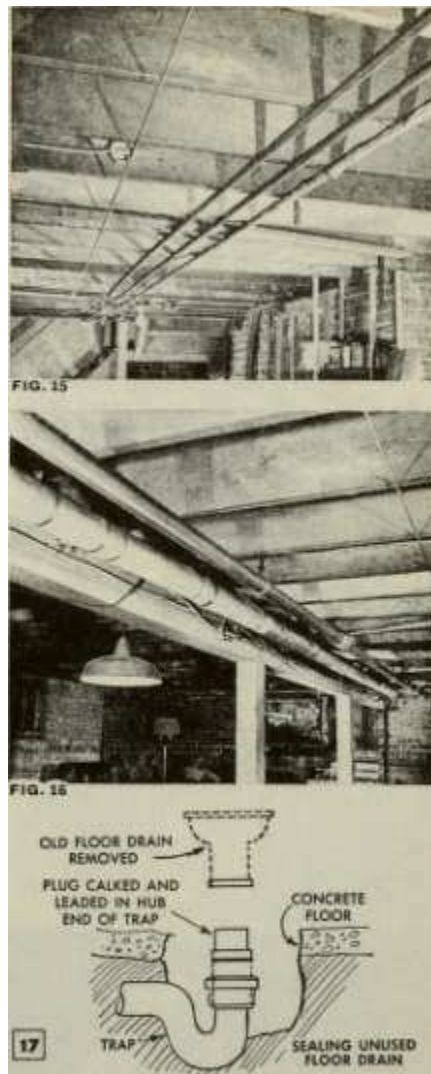
Where pipes are to be transposed, read over details on fitting pipe to be sure of accuracy. Galvanized, brass or copper pipe is used for water distribution lines, ordinary black pipe for gas lines. It is not advisable to make large notches in joists to accommodate several pipes as this will weaken the joists considerably. Notching joists to a lesser degree so that one or two lengths of flexible electrical cable (if permitted by local code), or metal conduit, can be sunk flush with the edge of the joists is not objectionable usually. However, care must be taken then to prevent driving nails into electrical conductors at the time when wall covering or trim is applied. Instead of notching joists for this purpose and locating cable where it is vulnerable to nailing, it is better to drill holes through joists and thread the cable through them. This, of course, is done after shutting off the electrical current at the entrance switch, and disconnecting the cables where they connect to boxes at both ends.

For drilling such holes you will find an electrician's offset brace convenient. You can also use a portable, electric drill fitted with a short wood-boring bit. Plan the location of electrical outlets before relocating old cables or conduit. Some of these can possibly be reused. All changes in the wiring should be made at the same time.

Unused floor drains: Where a floor drain comes in the area to be used for a recreation room, and will no longer be used, it can be sealed and covered up. Sealing must be done tightly so that no sewer gases can escape. The proper way to do this is shown in Fig. 17. First remove the drain, after chipping away concrete around it. If the drain is sealed in the hub end of a floor trap with lead calking, this must be melted with a blowtorch. After cleaning out the hub end of the trap, a plug is inserted, calked and leaded. Unless you have the tools and material for this work it is best to have it done by a plumber. After sealing the drain, the hole is filled with gravel and the floor is patched with concrete.

Working from plans: Although it often is possible to build a basement room without

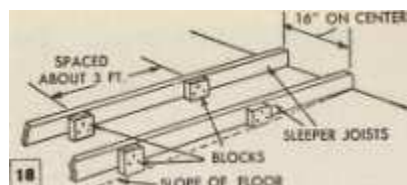
detailed plans, you can generally avoid many mistakes and problems by working from a plan. This should show the location of partitions, walls, windows, doors,



. SEALING UNUSED / FLOOR DRAIN

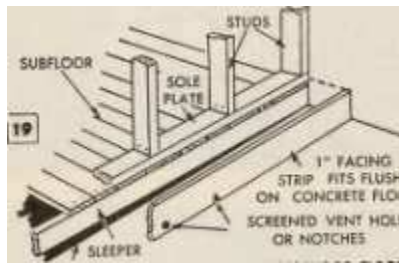
shelves, boxing around pipe groupings, closets, cabinets, electrical outlets, and other features you wish to include. The plan should also show the exact position of the chimney, girder posts and the stairway, if these are located within the limit.¹ of the recreation room.

Extra floor: An existing concrete floor may be entirely satisfactory for the finish floor, or as a base for a tile covering. A concrete floor having too much slope can be resurfaced to make it level. In such



SLEEPER JOISTS BLOCKS - SLOPE OF FLOOR BLOCKING ON SLEEPERS FOR FIRM LEVEL FLOOR

SUBFLOOR

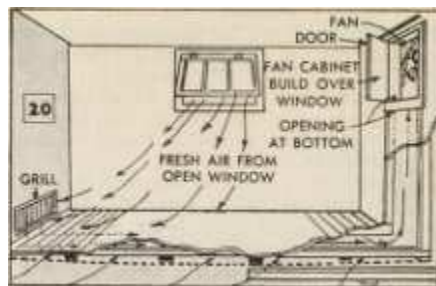
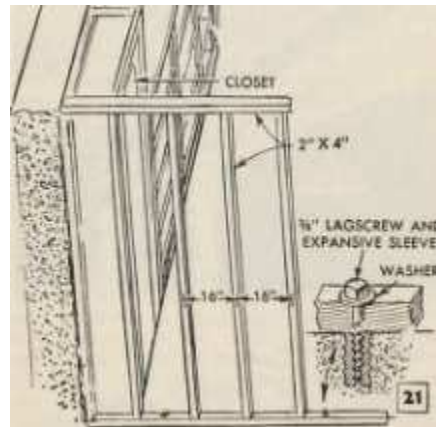


SLEEPER FLOOR SLOPE

1" FACING STRIP FITS FLUSH ON CONCRETE FLOOR

SCREENED VENT HOLES OR NOTCHES

PARTITION BUILT ON WOOD FLOOR



cases the added concrete topping should not be "feathered" to thin edges at the walls, but should be at least 1 in. thick at these points.

Another way of obtaining a level floor is to install a wood floor over the concrete, if there is sufficient headroom. Such a floor is laid on "sleepers" spaced 16 in. apart on centers. To support such a floor on the sloping concrete surface, you can nail blocks with 12-d. nails to the sleepers at about 3-ft. intervals as shown in Fig. 18. You may have to taper the ends of some sleepers so that the floor framing at the center will not be too thick. Concrete under a wood floor often must be water-pi'oofed by using asphalt-impregnated felt Then partitions must be erected for separating the loom from the rest of the basement are installed on the subfloor as shown in Fig. 19. Provisions must be made for adequate air

circulation under a wooden floor as shown in Fig. 20.

Partitions: In basements where no extra floor is needed, the sole plates of partitions are anchored to the concrete floor. First mark the exact location of partitions by means of a chalk line. Then mark off the



Photo courtesy Pittsburgh Coming Coiv-

» ^^

location of door openings up to which the sole plates extend. Mark crosslines on the plates indicating stud positions, and then drill $\frac{1}{4}$ -in. holes through the center of the plates for $\frac{1}{2}$ -in. lag screws. Space the holes in the plates about 3 or 4 ft. apart and so that they will come between stud positions as indicated in Fig. 21, starting 8 to 10 in. from either side of a door opening. Lay the plates in position and mark the hole centers on the concrete floor.

Use a star drill to sink the holes so that they will accommodate lead sleeves into which you drive the lag screws. Slip washers under the heads of the lag screws and attach the plates, being careful to get ones on opposite sides of door framing, and also those butting together, in perfect alignment. When installing studs you cut and fit them individually because they will vary in length on account of the floor slope. Partitions also can be made of hollow tile, the surfaces of which are to be plastered. You can also use glass blocks as in Fig. 22 for partitions that do not carry any weight.

Treatment of outside walls: In some cases, smooth vertical side walls of a basement, particularly if they are of poured concrete, are entirely presentable after they are painted. If desired, cement plaster can be applied to obtain a smooth and water-resisting finish. Dry concrete must always be wetted before applying cement plaster. It often is preferable to finish outside walls of a basement to match the wall covering on the partitions. For this purpose nailing bases for the wall covering must be provided either by installing a regular 2 by 4-in. stud framework, like standard partitions, or installing furring strips to the masonry surfaces.

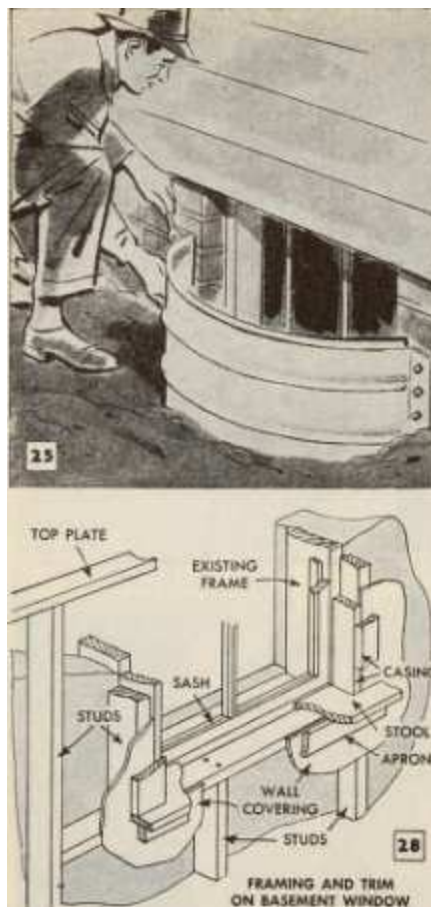
Installation of furring strips requires sinking holes for lead sleeves or wood plugs. The cost of a stud wall is more than that of furring but the installation time usually is much less. Generally the few extra inches of space sacrificed for studs will not be noticeable. Sometimes 2 by 2-in. stud framework is satisfactory, particularly if the studs can be fastened to walls at their centers, or to blocks attached to the walls. Framing around a chimney must be spaced 2 in. away from the brickwork, and must not be attached to the brickwork, in accordance with most building codes. It is generally best to install a stud framework if the foundation walls are very irregular. Flush electrical outlets are more easily installed in such a wall than in narrower ones.

Installation of furring strips: To attach furring strips on concrete or masonry, you mark their locations first. If they are to



be applied vertically the spacing is 16 in. on centers generally. If applied horizontally, as necessary for a plank-type of wall covering, or when small panels are used, furring strips are arranged about 12 in. apart, starting about 1 1/2 in. above floor level. Usually 1 by 3-in. stock is used for furring but sometimes 2 by 2-in. stock is preferred.

After marking the position of the strips, you drill holes in the wall at 3-ft. intervals for 3/4-in. lead sleeves or 3/4-in. hardwood plugs—dowel stock. The holes should be



FRAMING AND TRIM ON BASEMENT WINDOW

about $\frac{1}{2}$ or 1 in. deep, and can be drilled with an electric drill provided with a masonry bit of proper size, or with a power-driven hammer. If you cannot borrow such a tool, you'll have to resort to the more arduous task of sinking the holes by hand with a star drill and hammer. Nails driven through the strips into the sleeves or plugs expand the latter so that they become firmly anchored in the holes.

Lead sleeves are not affected by moisture and temperature and therefore are not apt to loosen. Many contractors find that hardwood plugs snugly fitted into round holes will also hold indefinitely because the usual dampness in basement walls prevents the plugs from drying out and shrinking. Furring strips must be installed so that the wall covering will be plumb both vertically and horizontally.

Air circulation in outer walls: A slight circulation of air in the space between the

SIZE OF ORIGINAL WINDOW

GRADE

WELL OF CORRUGATED STEEL OR CONCRETE

SIZE OF S. ENLARGED WINDOW

WHITE-PAINTED WALL OF WELL AT ANGLE FOR GREATER LIGHT REFLECTIVITY

DRAIN

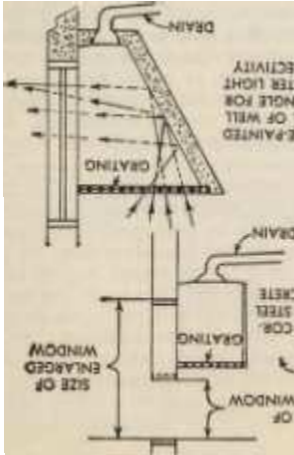
wall covering and a masonry or concrete wall prevents mustiness in case of slight dampness. Circulation can be provided through notches cut in the sole and top plates, midway between studs, in which case a baseboard is installed about $\frac{1}{2}$ in. above the floor. Where horizontal furring strips are used, they are not butted together at the ends but are spaced $\frac{1}{2}$ in. apart, or they may be notched, to permit air circulation. Outlet holes at the top of the wall can be concealed with corner molding.

Insulation on side walls: Where cold winters are experienced, basement walls sometimes need insulation. The low temperatures of exposed, above-ground portions of concrete or masonry are readily conducted to the lower portions. In such cases, a regular 2 by 4-in. stud wall permits the installation of batt or blanket insulation. This type of insulation should not be placed in direct contact with the wall but separated from it by an air space. You can also use asphalt-impregnated insulation, 1 or 2 in. thick as may be necessary. This is applied directly against the masonry wall[^] being adhered to it by means of asphalt[^] adhesive. Often rigid insulating wall board applied over furring strips will provide[^] sufficient insulation besides good appearance as a wall covering.

If a concrete wall is absolutely free of dampness due to infiltration from the outside, the space behind the insulation may be sealed. However, if the wall does become slightly damp, which is frequently the case, the space should be provided with air circulation as already explained. One objection to this method is that cold air enters the basement through openings at the floor level and causes cold floors. To avoid this the openings can be kept closed

during cold weather but should be open at other times.

Boxing to conceal ducts and pipes: Often ducts and pipes of a heating system are left exposed in a basement, which has the obvious advantage of providing heat. However, if



you wish to conceal them, you frame around them as shown in Fig. 23. The framing usually is 2 by 2-in. stock and is nailed to joists. Crosspieces of the framing should be spaced at 16-in. centers generally. Since boxing around heating pipes reduces the amount of heat supplied to a basement, it may be necessary in some cases to install an auxiliary heater, such as the wall-type heater shown in Fig. 24. Gas and water meters, and vertical piping along walls may be enclosed in closets which also provide extra storage space.

Window treatment: Windows can be lengthened if suitable wells are provided on the outside as shown in Figs. 25 to 27. Such wells should be provided with drains at the bottom to lead water away from the house. The inside of concrete wells can be painted light for greater light reflectivity. A bright, galvanized surface of wells like the one shown in Fig. 25 also reflects maximum light. Window wells should be covered with gratings as a safety measure. A window well having a sloping wall as shown in Fig. 27 reflects more light than one having a vertical wall. The method of framing basement windows and adding trim is shown in Fig. 28.

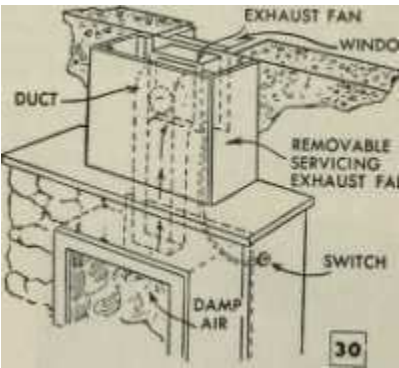
Wiring outlets: Due to low headroom in many basements, it is a distinct advantage often to install recessed lighting fixtures. Cove lighting with fluorescent lamps gives a soft, over-all illumination. Walls should be provided with some flush receptacles at points where it may be desired to attach lamps or other electrical equipment. Wiring should be completed before the walls are covered.

Finishing touches: After all framing has been completed, you apply the wall covering—the ceiling first unless it is already covered. Fig. 29 shows how wide pieces of wallboard or plasterboard can be held securely against the ceiling for nailing by means of a T-shaped brace. After the wall covering has been applied, you hang doors and install trim. The baseboard is last, after the finish floor has been laid. When floor tile is to be applied directly to concrete, be sure to use the type of tile and the adhesive recommended specifically for application on concrete floors that are in direct contact with the ground.

Paint jobs are soon ruined if there are active salts in the concrete, and therefore it is generally not advisable to paint a floor within a year after it has been laid. After that, traces of salt can be sealed with a



FIG. 29



EXHAUST FAN

WINDOW

REMOVABLE FOR SERVICING EXHAUST FAN

suitable concrete primer. If you paint a concrete floor, be sure to clean offT all grease and dirt from its surface with a solution of grease-absorbing compound, such as tri-sodium phosphate, then rinse off thoroughly and let the floor dry completely before painting.

Basement fireplaces: If you have visions of installing a fireplace in your basement rumpus room, remember that this is a major undertaking. It is generally impractical unless the chimney has an extra flue that is not used, and is not connected to any other heating source. An artificial fireplace located against a foundation wall can be used for ventilating a basement as shown in Fig. 30. It should then be built so that the discharge fan will be accessible. Such ventilation has the advantage of exhausting the heavier, moisture-laden air from the floor level.

REFRIGERATOR SERVICING

Much of the repair work done on domestic refrigerators requires special tools and equipment, but if you knoyv how a refrigerator works—and why—there are simple

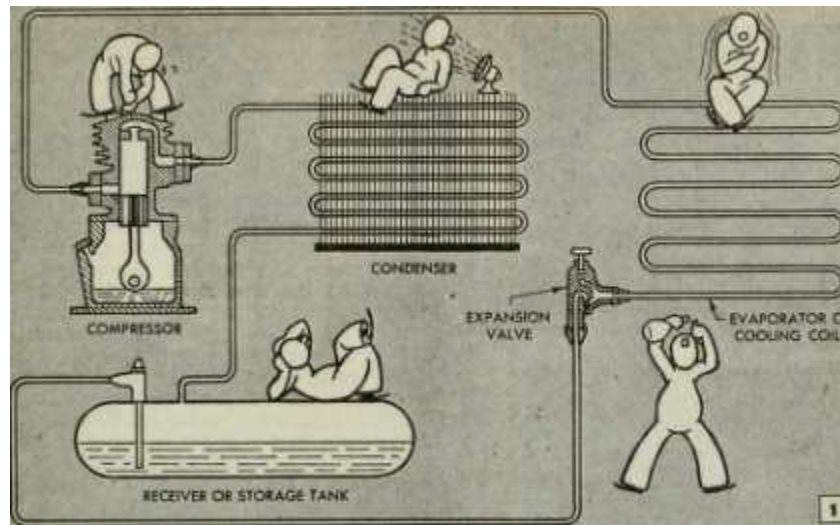
maintenance routines that you can follow to keep the unit in condition and make frequent calls for a serviceman unnecessary

/Like any fairly complex mechanism, a mechanical refrigerator must be serviced properly and maintained if it is to deliver the peak performance for which it was designed. Some repairs, which do not require "opening" or "pumping down" the system, are fairly easy to make and can be done with ordinary tools. (Opening or pumping down a system refers to the removal, or partial removal, of all refrigerant to get at some particular part. To do this, special equipment is needed and generally it is better to have a serviceman do the work. Also, when a system is opened, you may be handling gases that are toxic and, therefore, dangerous.) Only repair and maintenance that do not require opening the system are discussed here. « / Fig. 1 shows schematically how a re-V frigeration system works. Warm, low-pressure refrigerant vapor is admitted to the compressor where its temperature and



pressure are raised and then it passes to the condenser where the vapor is liquefied and partially cooled. From here the liquid goes to the receiver, which functions as a storage tank to supply refrigerant according to the fluctuating demands of the system. At the expansion valve the liquid is metered and admitted into the evaporator or cooling coils; these are the coils that generally encase the ice-cube trays and also refrigerate the interior of the cabinet. t/ From the point where the refrigerant V is compressed to where it passes thi'ough the expansion valve or a similar metering device, it is under high pressure and this generally is referred to as the "high" side of the system. At the expansion valve the pressure and temperature are reduced so that the liquid will absorb heat and "boil," thereby evaporating and cooling the interior of the refrigerator. After the refrigerant passes thi-ough the cooling coils, it returns to the compressor and the cycle is repeated. Fronj the point where the liquid leaves the expansion valve to where it is compressed again, it is under low pressure and this is the "low" side of the system.

</ While the foregoing isn't typical of any y one unit, it's a general indication of how mechanical refrigeration by means of a compressor is accomplished. Other types of compressor systems include those which have high and low-side float valves, restrictors and capillary tubes instead of expansion valves. In some units a plate-type



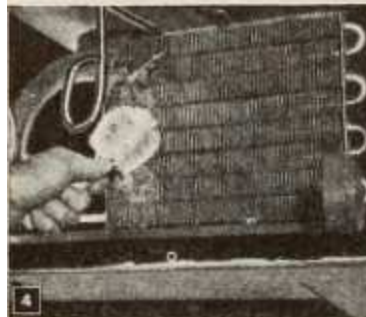
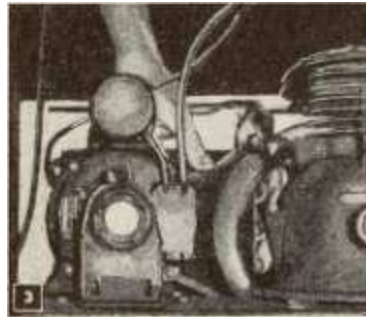
in brief, here's what happens during a compression refrigeration cycle: Refrigerant is raised to a high-pressure gas in the compressor, liquefied in the condenser, stored in the receiver, metered at the expansion valve, "boiled" in the evaporator to cool the interior of the cabinet, and returned to the compressor to complete the cycle

condenser is combined with the receiver and is air-cooled instead of being the fin-and-tube type, Fig. 4, that is cooled by a fan. »/ To start and stop the unit when refrigeration is needed, there is a system of automatic controls. Usually these are switches or relays that are operated by temperature or pressure, and if they do not function properly, they should be adjusted or replaced by a serviceman. Sometimes adjustments can be made by referring to instruction sheets pasted inside the cover of the switch box. However, first check the electrical current to be sure that it is supplying power and test the motor for proper operation. When possible, also check the wiring for shorts, grounds and continuity. If the unit is of the "hermetic" type, the motor and compressor are sealed in a housing and require replacement as a unit if defective in operation. The "open" unit has the motor connected to the compressor by a V-belt drive. "Semihermetics" are a combination of the open and hermetic types, having a sealed compressor that is direct-connected to the motor. Any of these types can have either a reciprocating compressor, which has pistons that function like those in an automobile engine, or a rotary compressor that is like a positive-action pump.

/An efficient machine is one that's clean, and a condensing unit (compressor, condenser, receiver, metering device and evaporator) is no exception. Ac-

cumulations of dust, dirt and oil act as insulation and prevent proper air circulation and removal of heat from the unit. This is especially true of the condenser. Both the fin-and-tube type and the plate condenser should be cleaned with a brush to remove any

accumulated dirt. Fig. 4. With the fin-type condenser, be sure that the passages between the fins are free of obstructions



and check to see that the fan blades are not bent or otherwise operating improperly. When working around an open condensing unit, always disconnect the refrigerator from the power supply as operation of the unit is automatic and it may start or stop at any time, catching a tie or loose clothing. ./ In connection with air circulation, an-y other point to check is the location of the refrigerator. For most makes there should be at least 3 in. between the back of the cabinet and the wall. Fig. 2, and as much or more space above and at the sides. Any pockets which restrict the free flow of air cause inefficient operation. This may be indicated when the refrigerator operates in short cycles; that is, starts and stops frequently.

/When going over an open condensing unit, always check the V-belt drive for tension and alignment. Tension can be tested by pressing the belt with the thumb. Fig. 3. There should be about Vz in. deflection. If the belt is too loose, there will be slippage and loss of power. One of the simplest ways to check alignment is to place a straightedge against the face of the compressor pulley and see that it is parallel with the face of the motor pulley. When a belt becomes loose or frayed it should be replaced. This is done by loosening the motor-mounting bolts and sliding the motor toward the compressor. After the belt has been replaced, check the new one for tension and alignment, but remember that it will stretch somewhat.

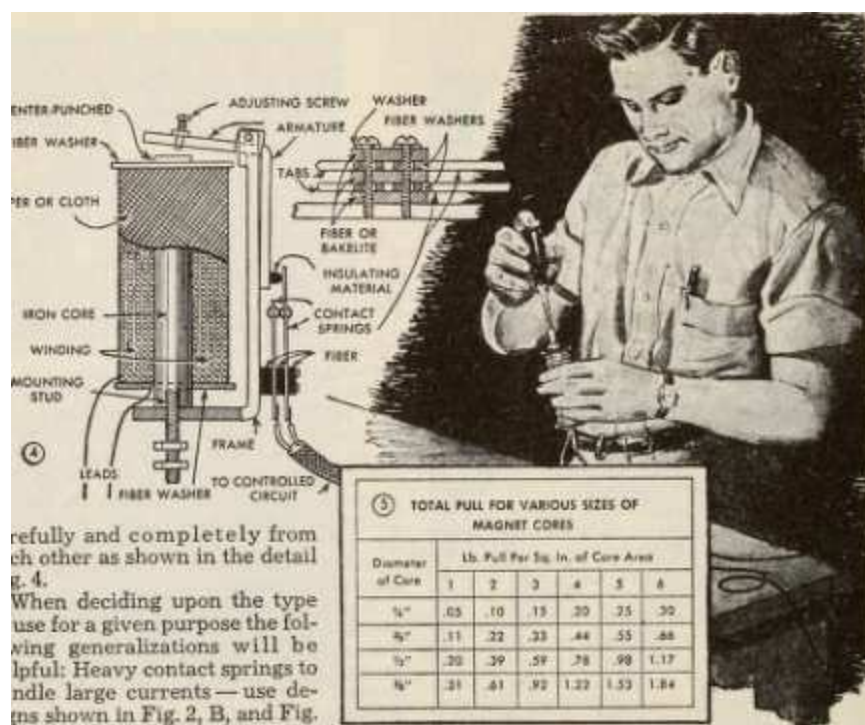
/Although most motors do not require frequent oiling, if they run dry they will overheat and burn out bearings. Lubricate the motor according to instructions for the particular type that you have, but do not use too much oil or grease, as this, too, will cause overheating. Be careful not to drop oil on the V-belt as this causes deterioration of the rubber. When testing the drive, tighten all mounting bolts to eUminate a possible cause of excessive vibration.

/Sometimes a compressor runs continuously or too long. Some causes for this are an excessive refrigeration load, or food placed in such a way as to obstruct the circulation of air inside the cabinet so that only the space around the evaporator coils is cooled. When placing food in the refrigerator, do not have it above room temperature. /It may be necessary to replace the gasket around the refrigerator door if it becomes loose and allows cold air from inside the cabinet to leak and cause frequent operation of the condensing unit. The gasket can be replaced by removing the screws or loosening the metal flanges that hold it in place. Fig. 5, and inserting new strips. To keep the unit neat appearing, repair chips or scratches with porcelain enamel or glaze, Fig. 6, or use a lacquer. Clean the damaged area before patching.

AMPERE-TURNS

CENTER-PUNCHED FIBER WASHER

PAPER OR CLOTH



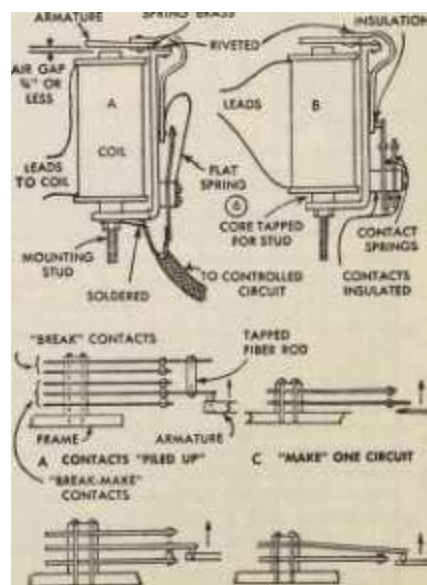
carefully and completely from each other as shown in the detail Fig. 4.

When deciding upon the type to use for a given purpose the following generalizations will be helpful: Heavy contact springs to handle large currents — use designs shown in Fig. 2, B, and Fig. 4; Light contact springs to handle medium or small currents — use design shown in Fig. 6, B; simple two-contact relays for low voltages—use design shown in Fig. 6, A, and for sensitive relays to operate on very small currents such as those available from photoelectric cells, radio tubes, etc., use design shown in Fig. 2, A.

The frame and armature should be formed from 1/8-in. soft flat iron, which should be about the same width as the diameter of the coil to be wound. Contact springs are made from nickel silver or spring brass, and contact units may be assembled as in Fig. 7, details B, C and D. Two or more spring units also can be operated by one armature, either "piled up" as shown in Fig. 7, A, or side by side as in Fig. 9. Contact points for light and medium currents can be made from silver wire, forced into a hole drilled in the spring and then riveted down as in Fig. 8. For heavier currents, silver rivets or tungsten contacts of the type shown in Fig. 8 should be used. The arm which opens and closes the contact springs must be an integral part of the armature or must be rigidly attached to it. It also should be insulated from the contact springs as in Fig. 11.

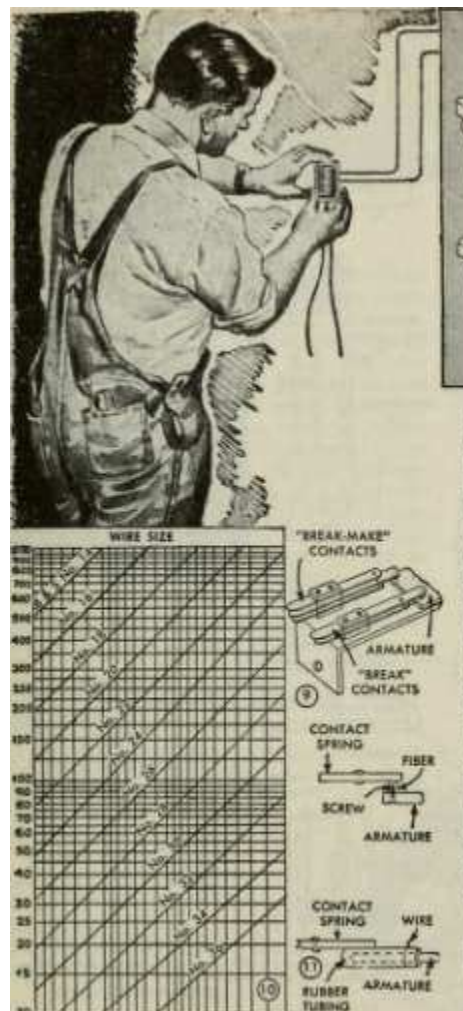
Having determined the general design characteristics the next step is to calculate the coil size and winding data. The gov-

SPRING BRASS



B "BREAK-MAKE" TYPE

"BREAK" ONE CIRCUIT



4 3.0 2.0 1.5 1.0 .8 .7 .6 .5 .4 .3 .25 I AVERAGE DIAMETER OF COIL (INCHES)

^DESIGN FACTOR

erning characteristic is the pull required of the magnet which wiU operate the relay. This,

in turn, depends on the tension of the springs which hold the armature and contacts in their normal positions. Tension on an average contact spring should not exceed 1 oz., or .0625 lb., and may be less with very light springs. For a greater number of contact springs operated by one armature, or if an auxiliary spring is used, the pull required will be correspondingly greater. After estimating the pull required, the next step is to determine the core size. The core required will range from V^{\wedge} to V_z in. in diameter for most relays. For ordinary pur-

IRE

CONTACT SPRING

<S>,

WIRE RIVETED

BRASS

SHANK AND

BODY

BRASS BODY AND \wedge SCREW/ - $\wedge\wedge\wedge\wedge$



SILVER-ALLOY RIVET CONTACTS

TUNGSTEN

RIVET CONTACTS

TUNGSTEN SCREW-TYPE CONTACTS

(J) METHODS Of MAKING CONTACTS

poses a y^{\wedge} -in. diameter core will be ample. However, for larger or heavy-duty relays, a heavier core may be more desirable. Refer to Fig. 5, from which it wiU be easy to calculate the pull required per sq. in. of core area, that is, the cross-sectional area of the core. As an example, suppose it is desired to construct a relay to operate three light springs. The pull required would be .0625 by 3 or .1875 lb. Now, referring to the table it will be seen that a

$\frac{1}{4}$ -in.-diameter core wound to give a pull of 4 lbs. per sq. in. of magnet surface will pull .2 lb., or a little more than the requirement. However, as indicated in Fig. 5, a $\frac{1}{2}$ -in. core wound for a pull of 2 lbs. per sq. in. or a $\frac{3}{4}$ -in. core wound for a pull of 1 lb. per sq. in. would also meet the need. Since it is desirable to use the smallest practical core diameter, the $\frac{1}{4}$ -in. core is selected. However, for low-voltage relays it is sometimes desirable to use a larger core to reduce the current required.

Next step is to determine the number of ampere-turns required to give the desired pull. This depends on the air gap, or space between the end of the core and the armature when the relay is in the open position. See Fig. 6, A. This gap should be not more than $\frac{1}{4}$ in. and preferably should be less. In highly sensitive relays the allowable gap usually is between $\frac{1}{16}$ and $\frac{1}{8}$ in. For purposes of illustration use an air gap of $\frac{1}{16}$ in. Referring to Fig. 3, find the air gap, $\frac{1}{16}$ in., along the left-hand edge of the chart, then read straight across to the line marked with the required pull per sq. in. Then read down to the bottom where the number of ampere-turns required will be found, in this example approximately 660. Thickness of the coil should roughly equal the diameter of the magnet core, in this case approximately $\frac{1}{4}$ in., making the overall diameter of the coil $\frac{3}{4}$ in. Length of the coil proper should be about 1 in., which is the length of the winding space. The core

WASHERS



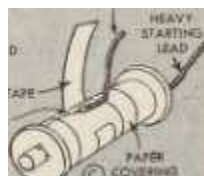
HEAVY LEAD

FOR CONNECTIONS

ORDERED HEAVY FINISH LEAD

HEAVY STARTING

CENTER PUNCHED



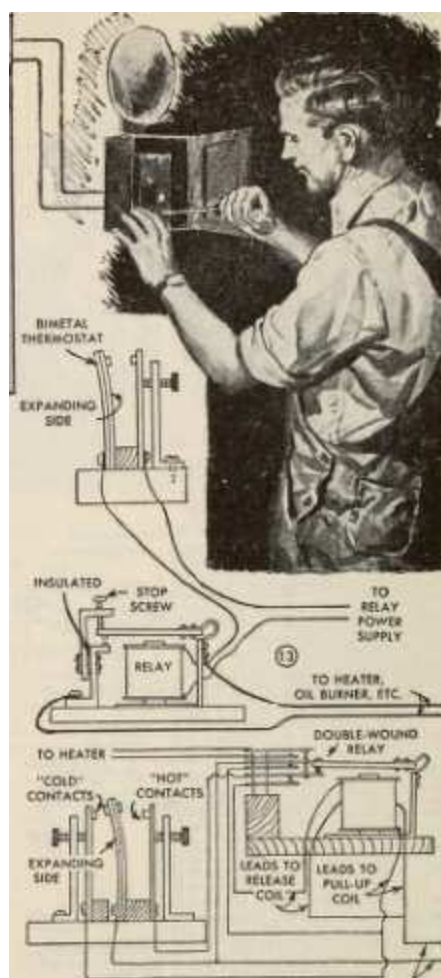
(12) METHODS OF WINDING THE COIL

PAPER (C) COVERING

must be somewhat longer to allow for thickness of the insulating washers. However, these dimensions are not critical. The coil can be made longer or thicker.

The wire size for the coil is determined by the operating voltage. As an example assume that the relay is for an alarm system which will be operated on four No. 6 dry cells in series, giving a total of 6 volts. The "design factor" for a d.c. relay is found by dividing the ampere-turns by the voltage, that is, 660 ampere-turns divided by 6, or 110. Next determine the average diameter of the coil by adding the diameter of the core to the outside diameter of the coil and dividing by 2. From this it will be found that the average diameter of a coil $\frac{1}{2}$ in. outside diameter, wound on a $\frac{1}{8}$ in. core, is 0.5 in. Now, with the aid of the chart, Fig. 10, find the design factor, 110, along the left-hand margin. Next, find the average diameter of the coil, 0.5 in., along the bottom. Finally, read straight across from the left and straight up to the intersection of the two lines. This intersection is nearest the line marked "No. 28 B & S," which is the size of wire required.

With these calculations completed you're ready to wind the coil after the manner shown in Fig. 1. First, cut the core $\frac{1}{2}$ in. long and fit a fiber insulating washer at each end with a space of $\frac{1}{2}$ in. between. Washers should be a tight fit and slightly larger than the outside diameter of the finished coil. Wrap the core with several turns of brown paper and coat with shellac. Start the winding as in Fig. 12, A and B, which suggest two methods of anchoring the starting end of the wire. Each two or three layers of winding should be wrapped with thin paper and coated with shellac. In winding d.c. relays it is not necessary to count the turns of wire but care should be taken to wind evenly so that the space will be filled uniformly. When the coil is finished it should be wrapped with paper or



TO RELAY POWER SUPPLY

varnished cloth. If wound with fine wire, heavier leads should be soldered on and taped securely as in Fig. 12, B and C. The coil then can be mounted in the frame in the manner indicated in Fig. 4.

Contact springs should be fastened rigidly to the frame and fully insulated from it with fiber, bakelite or a similar insulating material, as in Fig. 4. Usually it will be found that the greatest sensitivity is secured when this adjusting screw just barely extends below the lower face of the armature. Provide a lock nut so that the screw can be held in the proper position. Fig. 13 details the connections for two practical applications of relay-controlled circuits.

BttM Your Own RELAYS /^^,

msaa a-cuelays

RELAYS made according to instructions given earlier will not operate satisfactorily on alternating current. However, with minor changes in design, they can be made to operate on a.c. if they are connected in series with a dry-disk rectifier, as shown in Fig. 16. In such cases, the relay must not be operated at a.c. voltages higher than the rating of the rectifier used. Since that is usually less than the line voltage, the relay must be operated with low voltage from a transformer. The type of connection shown in Fig. 16, having a full-wave

bridge type of rectifier, should be used. To design a relay to operate on rectified a.c, it is necessary to calculate the pull and ampere turns as for a d.c. magnet. Then divide the ampere turns by the a.c. voltage and multiply by 1.35 to get the design factor. This design factor can be used in the same way as for a d.c. relay to determine the wire size from the chart, Fig. 21. The coil then can be wound

If the relay is to be operated continuously, frequently, or on a voltage of more than 25, it is best to use a coil wound on a laminated core. A

COIL FORM IS MADE OF WOOD

/

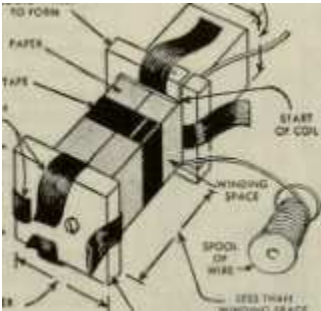


SLIGHTLY LARGER THAN CORE i\li.

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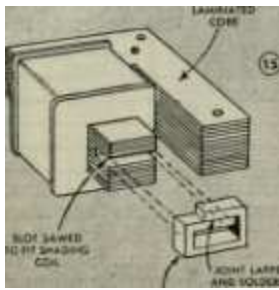
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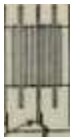


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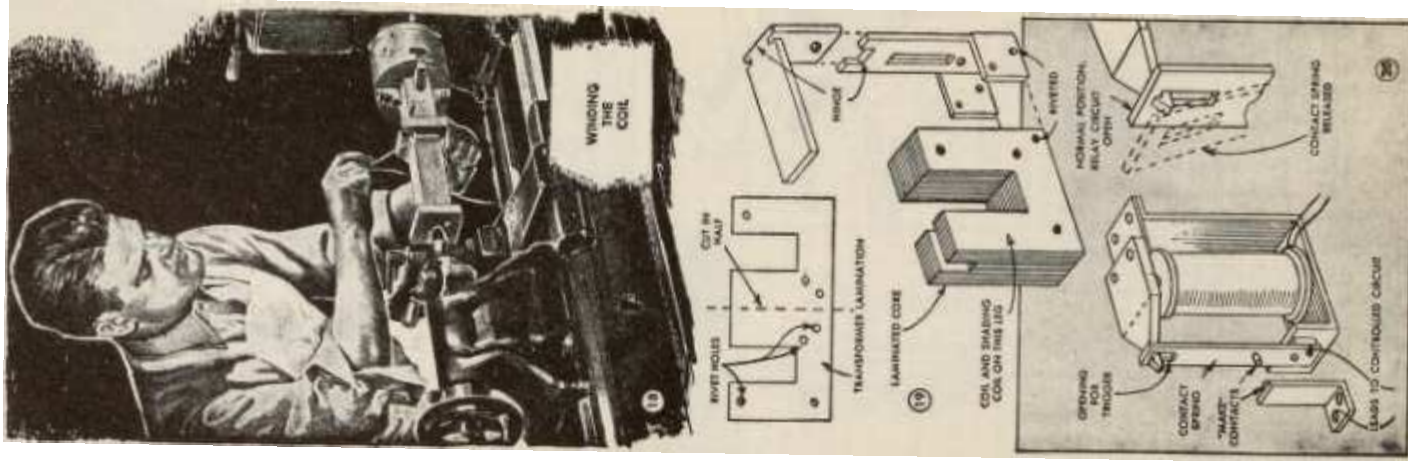




SIOI SAWED
 TO FIT SHADING
 COIL
 RECTIFIER
 UNIT FULL-WAVE BRIDCE TYPE
 TRANSFORMtR



T
 LOW VOLTAGE



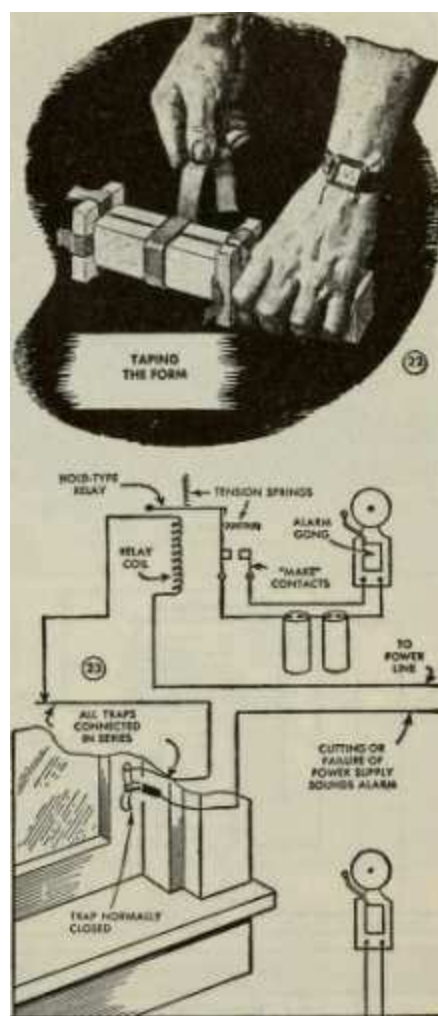
laminated core taken from an old radio transformer will be suitable but will require some alteration. The laminations can be sawed in half as in Fig. 19 to make a U-shaped core. The number of turns required to wind the coil for 60-cycle current can be found by multiplying the voltage by 4.7 and dividing by the winding-core area. For example, if the core is V2 in. thick and V2 in. wide, the core area is 0.25 sq. in., and to operate the relay on 110 volts a.c. will require 110 multiplied by 4.7 divided by 0.25 or 2070 turns.

On 25-cycle current, the number of turns is equal to 11.3 times the voltage, divided by the winding-core area. The wire size can be calculated by measuring the magnetic path, indicated in Fig. 17, dividing by the number of turns and multiplying by 50,000. This gives the required wire size in circular mils. Assuming that the magnetic path measures 4.25 in., the wire size required is 4.25 divided by 2070 multiplied by 50,000, or 103 circular mils. The corresponding gauge number can be found by referring to the chart, Fig. 21.

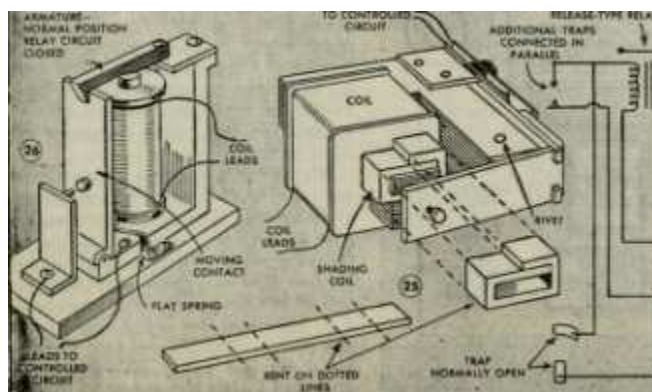
Here you can see that the closest size to 103 circular mils is No. 30 wire, which has a cross-sectional area of 101 circular mils. Using this wire size, which is only a little smaller than the calculated size, will slightly reduce the pull of the relay and also will reduce its operating temperature. Since a slight reduction in pull will be satisfactory in this case, the relay can be wound with No. 30 wire. If the next larger size of wire above the calculated value is used, the pull of the relay will be increased, which is not necessary, and the relay also will heat more, which is undesirable.

The coil can be wound directly on the core if desired, using essentially the same method as for a d.c. relay coil. However, due to the shape of the laminated core, it will be necessary to wind the coil on the

bottom of the "U." Another method is to wind the coil on a form and then slip it onto one of the arms of the core. In this case, the form should be constructed as shown in Fig. 14, about 1/8 in. larger each way than the core on which the coil will be fitted, and with the winding space between the end blocks slightly shorter than the space for the coil on the relay core. The form should be long enough to be held in the hand, Fig. 22, or in a lathe, Fig. 18, while winding. Small blocks are nailed to the form at the proper place, leaving a slight space between two of the blocks for the start end of the coil. The end block is attached with screws for easy removal, and the form is tapered slightly toward that end so that the finished coil can be slipped off the form without binding. Four pieces of plain cotton tape then are placed lengthwise in the winding space, and a strip of brown paper is wrapped two or three times around the form, Fig. 14. It is held in place by a band of friction tape. The coil is wound to the required number of turns in tight, even layers. After each layer of windings is finished, a layer of brown paper should be wrapped around the coil as additional insulation, Fig. 27. If space is lacking, use a layer of brown paper over every second or third layer of wire. When the required number of turns has been wound, the ends of the cotton tape are brought together over the coil and tied tightly. After removing the end block from the form, the coil can be slipped off and placed in correct position on the core. The shading coil, shown in Figs. 15 and 24, is very important, as without this an a.c. relay will hum. The shading coil can be installed by sawing a slot in one of the poles of the magnet, Fig. 30, and inserting a flat copper bar. This is looped around the laminations, Fig. 25, and the ends of the bar are lapped and soldered together. Un-

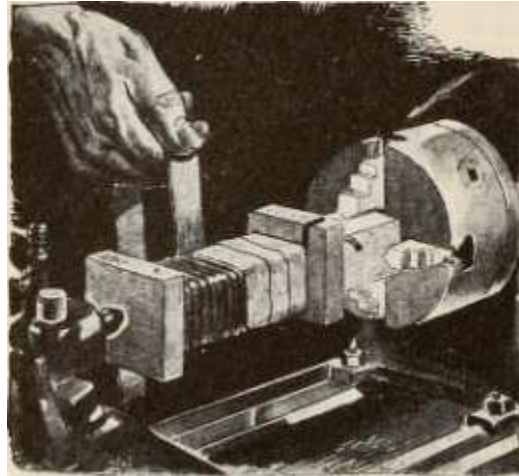


t ARMATURE-
f, NORMAL POSITION
RELAY CIRCUIT
CLOSED

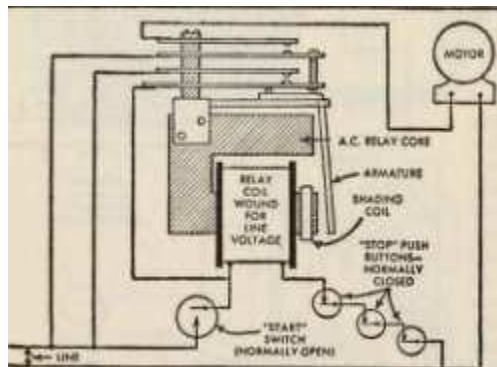


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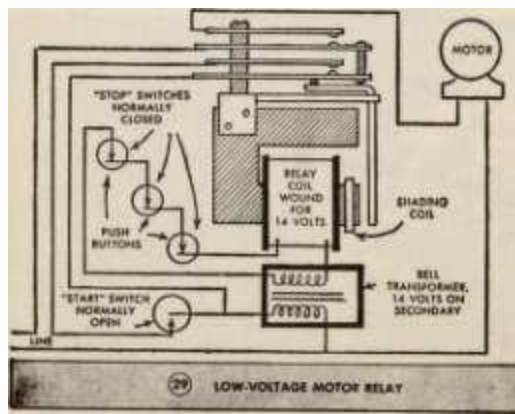
CUTTING OR
FAILURE OF
POWER SUPPLY
PREVENTS ANY
' ALARM



@
(27} EACH LAYER OF WINDING
WRAPPED WITH BROWN PAPER



@ SAFETY MOTOR RELAY



less the joint is lapped and soldered, the shading coil will not perform its function properly.

The armature of the relay can consist of a piece of flat iron of suitable dimensions, hinged as shown in Fig. 19 or in some other convenient way. A.c. relays offer the advantage of convenience of power supply and, if properly designed and built, can be made to operate satisfactorily.

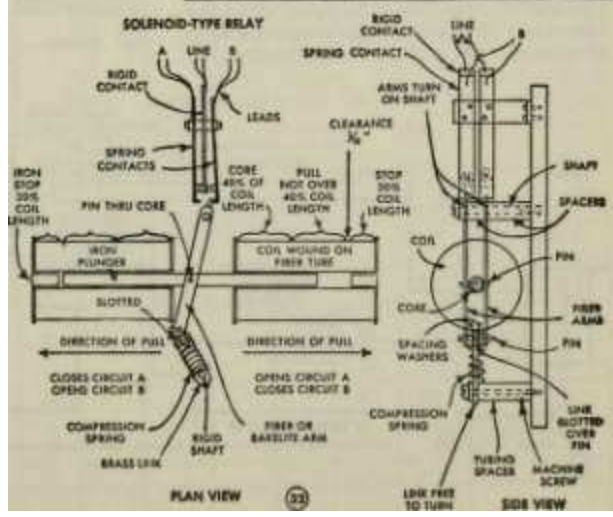
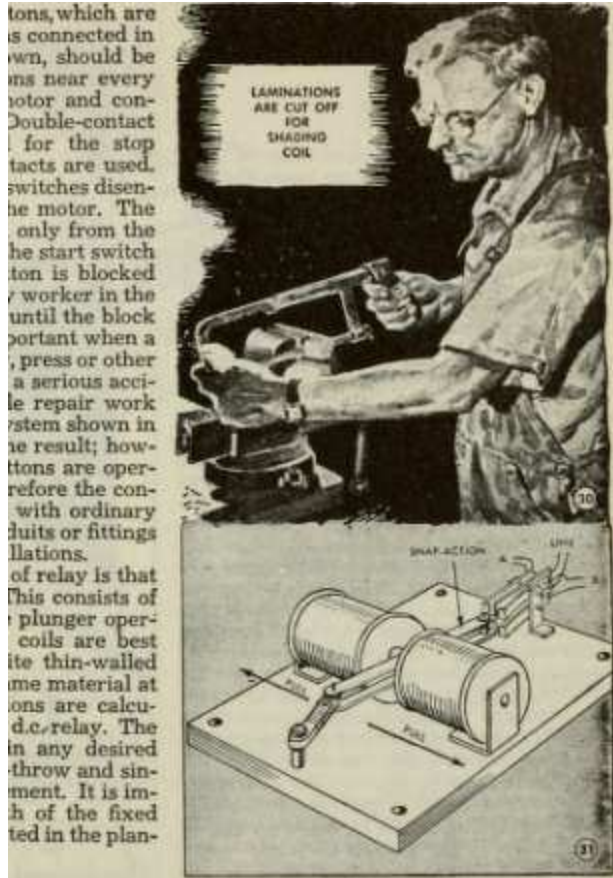
Numerous special types of relays will be found valuable in a number of applications. The "release" type relay shown in Figs. 20 and 24 can be adapted to alarm systems and the like. The advantage of relays of this type is that they do not require any power except when the traps are sprung. When the armature is pulled down, it releases the spring arm which closes the circuit and sounds the alarm. Once started, the alarm will continue to sound until the relay is reset by hand. The "hold" type relay shown in Figs. 23 and 26 is similar in action except that the contact spring is held as long as the relay current flows. The contact spring is released whenever the relay current is interrupted, and remains in that position until reset by hand. This type can be applied advantageously to burglar-alarm systems, as in Fig. 23, and has the advantage that cutting the power supply to the relay will sound the alarm. By use of fusible strips of metal foil in the circuit, the "hold" type relay also can be used for fire alarms. Although these types of relays generally are designed for d.c. current they can be operated on a.c. with dry-disk rectifiers, or if desired can be designed for a.c. using a laminated core as described.

Figs. 28 and 29 show two systems for control of motors which add to shop safety. The system shown in Fig. 28 uses an a.c. relay, operated directly off the line, to control the motor. Pushing the "start" button, which is a normally open push button, operates the relay and starts the motor. The second pair of contacts on the relay energizes the coil and holds the relay in closed

position. The "stop" push buttons, which are normally closed push buttons connected in series with the relay as shown, should be placed in convenient locations near every machine operated by the motor and convenient to every operator. Double-contact push buttons can be used for the stop switches if only the top contacts are used. Pushing any one of the stop switches disengages the relay and stops the motor. The motor then can be

restarted only from the main control station where the start switch is installed. If the stop button is blocked down, it is impossible for any worker in the shop to testart the machine until the block is removed. This is very important when a repair is being made to a saw, press or other machine which might cause a serious accident if it were started while repair work was being done on it. The system shown in Fig. 29 accomplishes the same result; however, the relay and stop buttons are operated on low voltage and therefore the control wiring can be installed with ordinary bell wire, without using conduits or fittings required with 110-volt installations.

Another very useful type of relay is that shown in Figs. 31 and 32. This consists of a pair of solenoids, with the plunger operating a toggle switch. The coils are best wound on a fiber or bakelite thin-walled tube, with washers of the same material at the ends. The coil dimensions are calculated just as for an ordinary d.c-relay. The contacts can be arranged in any desired way, using single or double-throw and single or multiple-pole arrangement. It is important to adjust the length of the fixed and moving cores as designated in the plan-view. Fig. 32. The solenoid-type relay can be used to stop and start a motor with push buttons, and has the advantage that current need not flow through the relay except during stop and start operations. Those uses of relays which have been described thus far doubtless wiU suggest other applications in which relays of different types can be made to serve a practical purpose in controlling circuits or appliances about the home, office or manufacturing plant. By using these fundamental suggestions it is possible to build much more elaborate control systems than those described.



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THERMAL leCLAYS

'THERE are two principal types of ther-^ mal relays; the hot-wire type, Figs. 35 and 36, and the thermostatic or bimetal type. Fig. 44. The hot-wire relay consists of a resistance

wire held under tension by a contact spring. When current from a battery or low-voltage transformer is passed through the wire it is heated and expands or stretches, permitting the contact to close or to open, depending on which type of relay is in use. Thermal relays can be used to control motors, lights, heaters or any other electrical apparatus. It is frequently desirable to insulate the low-voltage controlling circuit, which operates the relay, from the circuit that is to be controlled. A method of insulating the relay circuit from the controlled or operating circuit is shown in Fig. 37, A.

Both the hot-wire and bimetal types are actually delayed-action relays, since the contacts will not close until the wire has had time to heat and expand. The time interval between closing of the relay circuit and operation of the relay can be controlled by adjustment of the gap between the contacts, using a machine screw as in Fig. 37, B. Another method of speeding up the operation of a thermal relay is to slip a length of glass tubing over the resistance wire as in Fig. 40. This will retard heat loss from the wire and cause it to expand more rapidly. However, relays which are speeded in closing by this method will be correspondingly slower to open when the current is shut off. To slow down a hotwire relay, one can increase the gap be-

SPRING CONTACT

A.C

sumv

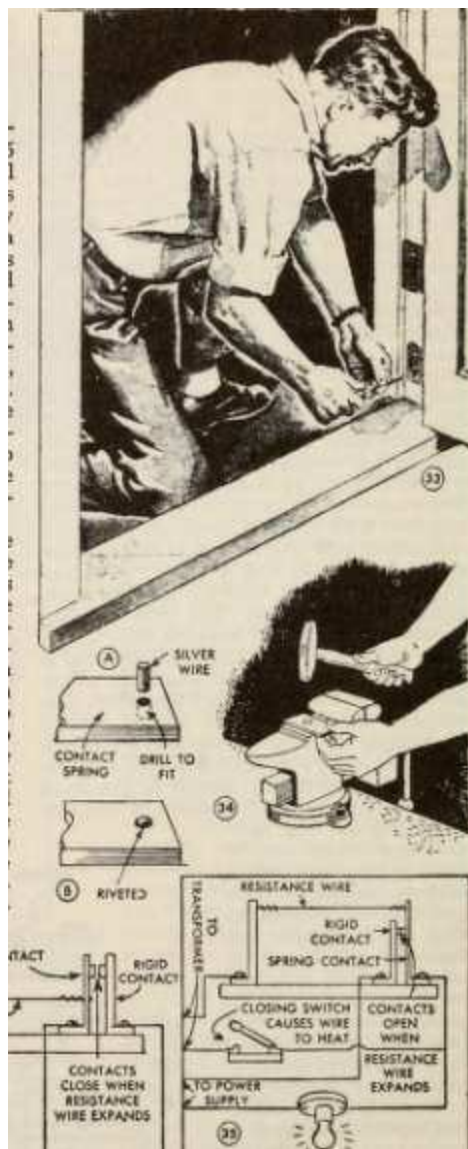
TRANSFORMER I

RESISTANCE WIRE

CLOSING SWITCH

CAUSES WIRE

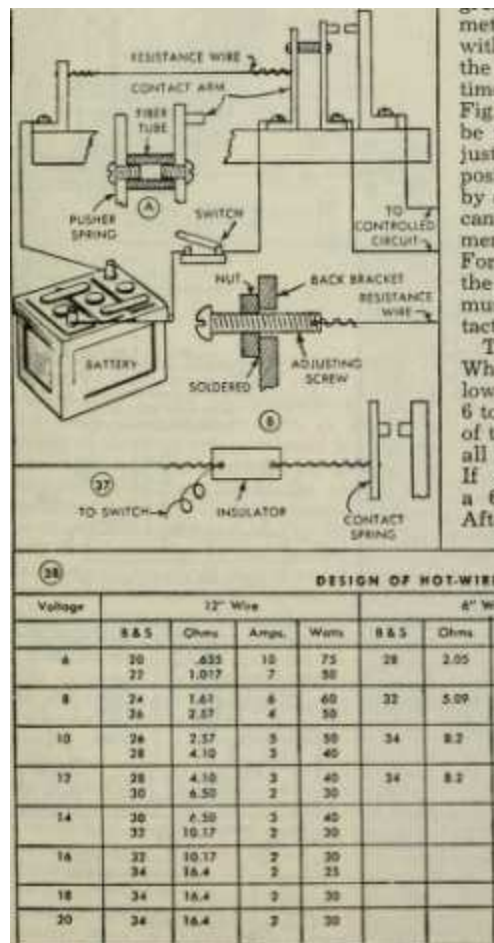
TO HEAT



HOT-WIRE RELAY
 TURNS ON MOTORS
 OR OTHER APPLIANCES
 6^
 1
 CONTACTS
 CLOSE WHEN
 RESISTANCE
 WIRE EXPANDS
 TO POWER SUPPLY



tween the contacts, but if the gap is to



tween the contacts, but if the gap is too great the contacts won't close. Another method is to connect a rheostat in series with a hot wire as in Fig. 43. By increasing the resistance it is possible to increase the time interval to almost any desired extent. Fig. 43 shows how two identical relays can be made to operate consecutively by adjusting the control rheostats to different positions. Details A and B in Fig. 41 show, by comparison, how a short length of wire can be used to give a larger contact movement as indicated by positions L1 and L2. For example, by connecting the wire in the position shown in Fig. 41, B, the wire must expand only $\frac{1}{2}$ in. to move the contacts $\frac{1}{2}$ in.

The design of hot-wire relays is simple. Where alternating current is available, a low-

voltage transformer with an output of 6 to 20 volts is the most convenient source of the relay current. By using low voltage, all relay wiring can be laid with bell wire. If alternating current is not available, a 6-volt battery, Fig. 37, can be used. After selecting the length of wire and the

DESIGN OF HOT-WIRE RELAYS

3.06

3.28

3.28 5.20

5.20 8.13

8.13 13.10

..^

voltage, the required B & S gauge of Ni-chrome wire can be determined with the aid of the table in Fig. 38. For example, if the wire is to be 8 in. long and operated at 14 volts. No. 32 or 34 wire can be used. The smaller wire will operate at higher temperature and give faster operation. Increasing the voltage with a given size of wire will increase the speed of action. The contacts should be capable of carrying the currents required. Silver contacts can be made as shown in Fig. 34^ A and B.

Hot-wire relays can be used in place of

TRANSFORMER

T^ IRAN₅POR

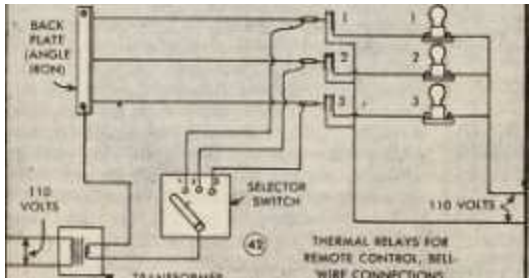
\ TO

CONTROLLED CIRCUIT

A.C. SUPPLY

SHIELDED HOT WIRE MAKES RELAY QUICK-ACTING

BACK PLATE (ANGLE IRON)



TRANSFORMER

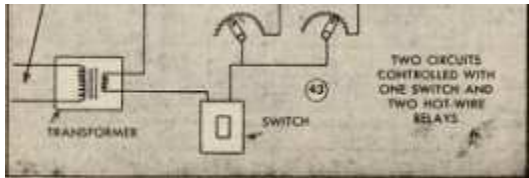
THERMAL RELAYS FOR REMOTE CONTROL, BELL-WIRE CONNECTIONS

J: ^

RELAY A - ^

1

] TO CIRCUIT



TO CIRCUIT A

TWO CIRCUITS

CONTROLLED WITH

ONE SWITCH AND

TWO HOT-WIRE

RELAYS

... ^' ■

CONTACTS AT n SAME HEIGHT AS WIRE

©

WIRE MUST EXPAND V»" TO MOVE CONTACT));"

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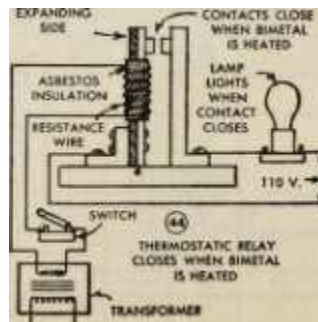
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WIRE MUST EXPAND ONLY !6" TO MOVE CONTACT H."

CONTACTS CLOSE WHEN BIMETAL n IS HEATED



THERMOSTATIC RELAY

CLOSES WHEN BIMETAL

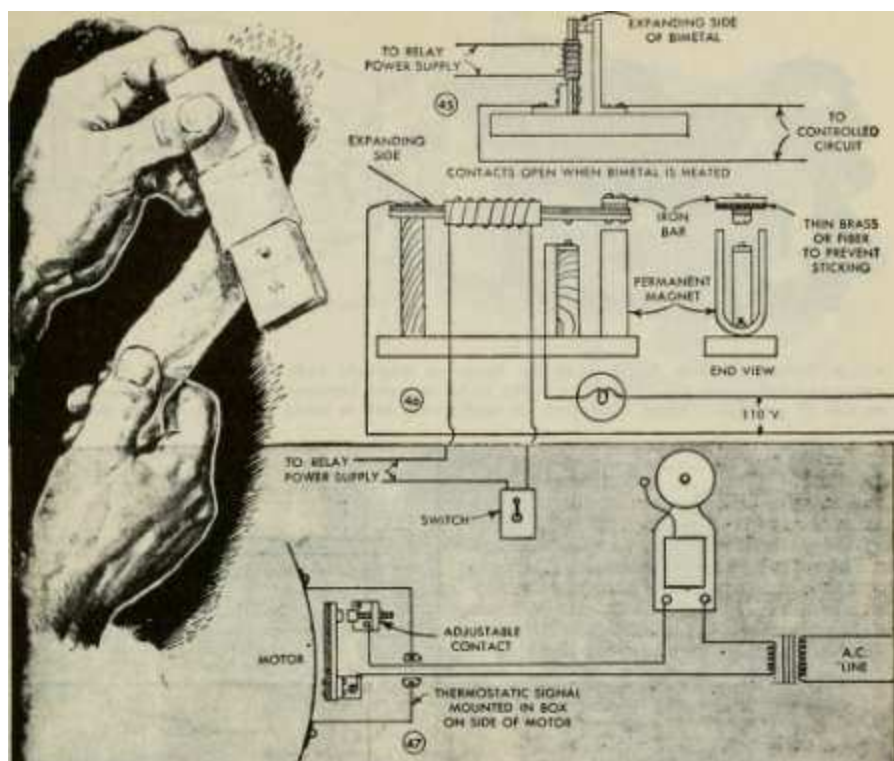
IS HEATED

TRANSFORMER

EXPANDING SIDE OF BIMETAL

TO

/CONTROLLED CIRCUIT

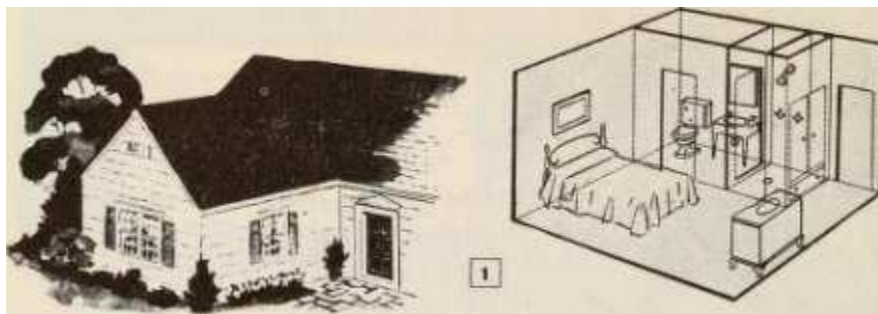


magnetic relays in most cases except on emergency controls where rapid action is essential or where heavy sparking will occur when contact is broken. In Fig. 42 a group of thermal relays is used for remote control of a group of lamps. By setting the selector switch any one of the remote circuits can be controlled and time delay can be made short or long. In Fig. 43 two motors are controlled by one switch, but can be made to go on at any desired time interval after throwing the switch by adjusting the rheostat controls. The delayed action hot-wire relay also can be used to ring a bell if a door is left open for an appreciable period of time, Fig. 33. Normal use of the door will not cause annoying ringing, but warning will be given if the door is left ajar.

Bimetal-type relays. Figs. 44 and 45, consist of a strip of thermostatic bimetal about which a heating element of nichrome wire is wound. A thin layer of asbestos paper is wound around this, as shown in Fig. 44. When the resistance coil is heated, it causes the bimetal to bend and open or close the contacts. To lengthen the time delay, a heavier layer of asbestos is wound around

the bimetal strip. To shorten the time lag, the nichrome wire is wound over a thin layer of asbestos paper, and a layer of asbestos is wound over the coil. In either case, the relay will be slower to open. The time lag of bimetal relays also can be controlled by adjusting the contact gap and by connecting* a rheostat in series with the heater coil, as already explained for hot-wire relays.

The design of bimetal relays often requires a little experimentation. Ordinarily, a strip of bimetal 0.030 in. thick, $\frac{1}{2}$ in. wide and 4 to 6 in. long will be suitable for the element. The size of nichrome wire required then can be found by referring to the chart, Fig. 39, which also gives the approximate length of wire required. The ends of the nichrome wire must be fastened to the copper-wire leads with machine screws or by brazing. Figs. 44 to 47 inclusive show a number of applications of bimetal relays. In Fig. 47 the bimetal thermostat without winding is secured to the metal frame of an electric motor so that a bell will ring if the motor overheats. Fig. 46 details a snap-action type of bimetal relay.



Above: Tailored to look like part of the house as originally built, this addition to the front of a story-and-a-half house, can be used for a den or for an extra bedroom and bath. Below: Similar addition on side of a two-story house is set back for appearance, and to retain usefulness of front side windows



REMODELING

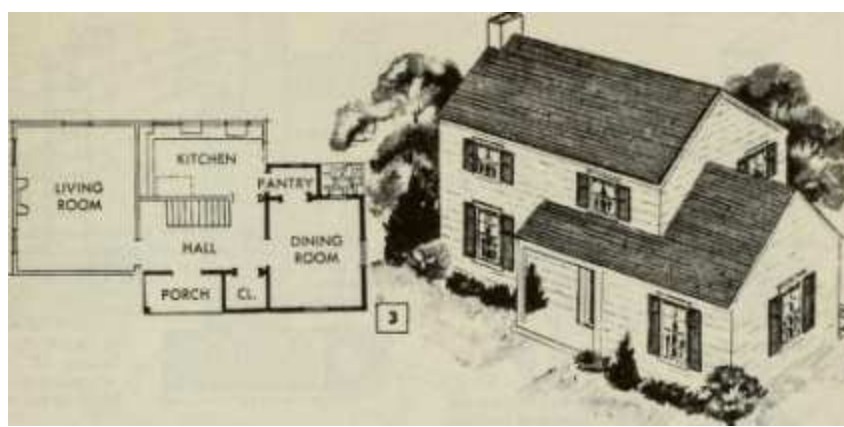
WHEN YOU FEEL pinched for living space, and the basement or attic is not suitable or desired for added rooms, it may be necessary to build a room or two on the outside. Such an extension should match the rest of the house for best appearance.

Well-planned additions: Generally an added bedroom or den can adjoin a living room. Figs. 1 and 2 show examples. A dining room can be added as shown in Fig. 3. Where a large living room is used for dining space, and this is not desired, look into the possibility of transforming the present kitchen into a dining room, and then add a new kitchen. This can sometimes be located between the house and garage as shown in Fig. 4.

Foundation requirements: An addition to the outside of a house requires a substantial foundation brought to the same height as the house foundation. In cold climates it is usually best to have a foundation wall of poured concrete or of concrete blocks as

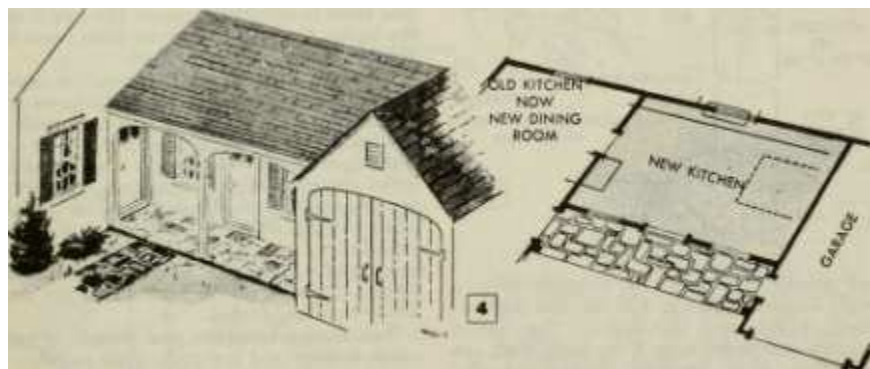
shown in details A, B and C of Fig. 5. For brick-veneer houses, the foundation walls are 10 and 12 in. thick with a portion of the wall often set back so that the brickwork can extend down to grade level as shown in detail D. For frame construction, foundation walls are usually 8 in. thick.

In warm climates an added room often can be supported by piers set on concrete footings. Readymade concrete piers are available in many localities. Piers also may be built up from bricks or concrete blocks. Where the latter are used each pier is neld together by means of a perforated Vi by 2-in. steel anchoring strip set vertically inside the blocks and imbedded in mortar. Foundation walls should always be extended to just below the depth of frost penetration. Where concrete piers are used, and they extend in the earth less than 3 ft., they should be cast integral with a footing, using y2-in. reinforcing rods.



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Above: An addition like the one in Fig. 2, extended beyond the front of a two-story house can provide a sheltered entranceway and a guest closet in addition to an extra room.
 Below: Modern kitchen and attractive breezeway built between house and garage permit previous kitchen to be used for a dining room



Crawl spaces: Where the floor of an added room, to be level with the house floor, is raised any distance above grade, the crawl space under it should be made accessible. Where the floor is relatively close to the ground, the crawl space may have to be excavated to provide sufficient clearance, in which case the foundation walls should extend beyond the depth of the excavation.

Closed crawl spaces must be provided with adequate ventilation to prevent humid conditions caused by moisture evaporating from the ground. Excessive humidity in crawl spaces may cause exposed wood, including joists and flooring, to rot in a comparatively short time. It also causes other undesired conditions.

Laying out foundation lines; Whether you are installing a foundation wall or just pier supports for an added room, the first step is to accurately locate the position of

Illustrations 1 to 4 courtesy Johns-Manville

the added room by laying out foundation lines. Two walls will join the house wall at right angles. On most frame houses covered with siding or shingles, the exact location of such joining walls is variable. On brick-veneer houses, where the extension is to be of the same

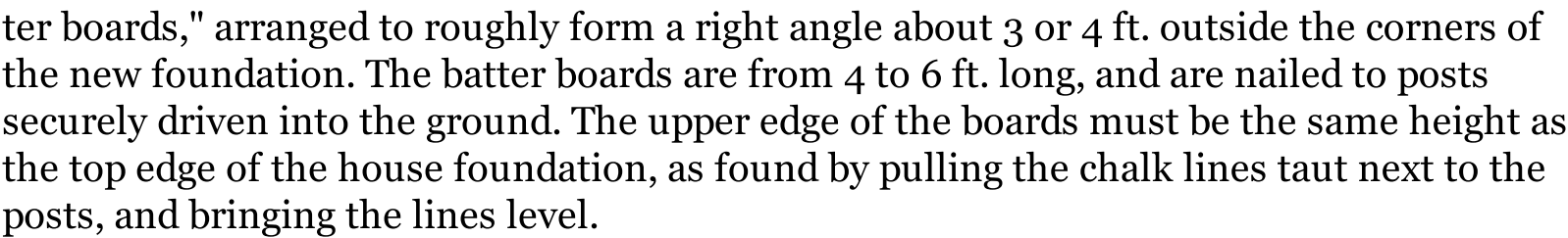
With these details in mind, you stretch two chalk lines from the top edge of the house foundation, and at right angles to it as shown in Fig. 7. Often the lower strip of siding or some shingles must be removed for this purpose, as these generally overlap the foundation wall. The lines are located to represent the outside edges of the new foundation. The free ends are held by "bat-



CONCRETE

PIER

6" OR 8" SQ



After the batter boards have been nailed to the posts, the lines are adjusted to come at right angles to the house wall. This is done by the triangulation method shown in Fig. 7,

using a 1 by 4-in. straight board, cut off or marked to exactly 10 ft., and also marked to indicate 6 and 8-ft. spans. With this measuring stick you mark off 6 ft. on the house wall and 8 ft. on the taut line. When the line is adjusted so that the 10-ft. dimension comes exactly between the marks on the house and line, the latter will be at right angles to the house. The adjustment of the line is made by moving it along the batter board. When the right position has been found, the batter board is marked with pencil or a very shallow groove. This assures retaining the correct position

SILL -^

"set-back

;(d) k-10"TC ^^ I 12"

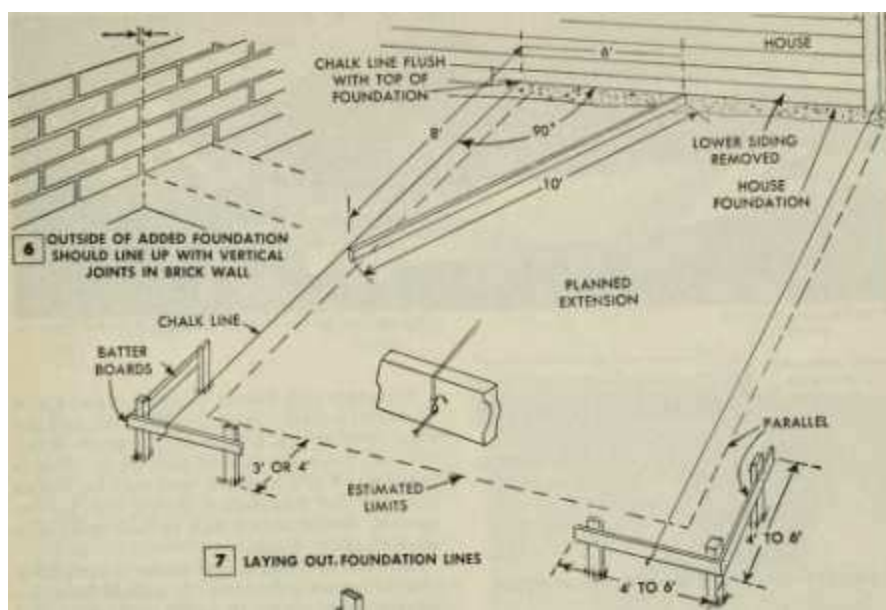
FOUNDATION FOR BRICK-VENEER WALL

when temporarily removed while digging trenches. The lines will be parallel if the adjustments were carefully made. A third line then is stretched across the two from the batter boards. The three lines must be at right angles to each other.

A plumb bob, suspended from the intersection points of the lines, will indicate the outside corners of the foundation, and is used when positioning the forms. The inner edges of the foundation may be indicated similarly with chalk lines. In laying out foundations, the lines and batter boards often are placed higher than the top of the foundation, and vertical measurements then made from the lines to foundation height. This keeps the lines out of the way while building forms.

Foundation trenches and forms: Where earth is firm and compact, such as clay, it may be dug out for shallow foundations, in which case the sides are undercut at the bottom to footing width. Wooden forms then are required above grade only as shown in Fig. 8. In loose soil where the form must extend below grade, as in Fig. 9, you dig trenches 20 to 24 in. wide. A long-handled, pointed shovel is most convenient for this purpose. Instead of using plank forms as indicated in Figs. 8 and 9, you may be able to borrow or rent preassembled forms faced with exterior-type plywood or tempered hardboard.

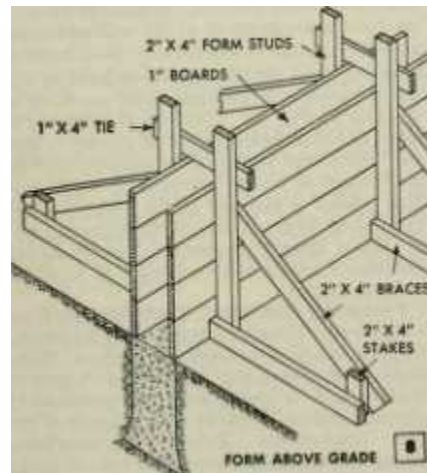
Footings: Footings on which most house foundations rest should extend from 4 to 6 in. on either side of a foundation and should be 8 to 12 in. high. They are usually cast separately on undisturbed, compact earth. A groove about 2 in. deep and 4 in. wide, with beveled edges, as shown in Fig. 5-A, often is formed in the top of a footing. This serves to interlock the footing and foundation wall. However, the footing and wall can be poured integrally, in which case the



ryi LAYING OUT. FOUNDATION LINES

2" X 4" FORM STUDS 1" BOARDS

1"X4"TIE -*{



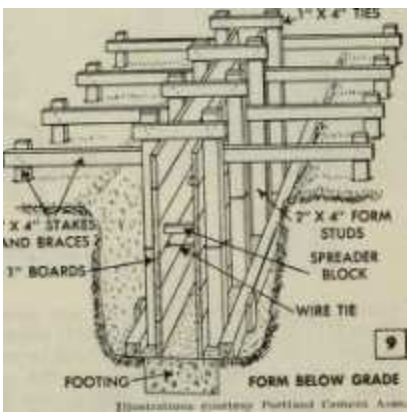
1"X4"T1ES

FORM ABOVE GRADE

top of the footing form on either side of the wall must be closed.

Concrete for foundation walls: Use a

1 : 2% : 4 mix of portland cement, sand and gravel or crushed stone respectively. About 5V2 gals, of water are required for each sack of cement when slightly moist sand is used. A rather stiff mix is preferred. The concrete is put into the forms in layers not deeper than 6 in. If possible, the entire wall should be cast in one continuous operation. If the work must be interrupted, as for an overnight period, you roughen the concrete surface with a stiff broom before it harden^. Then, before adding more concrete, wet the



2" X 4" STAKES' AND BRACES

FORM BELOW GRADE

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surface, and butter it with a Vz-'m. layer of mortar consisting of 1 part of portland cement and 2% parts of sand. In many communities it is possible to get ready-mixed concrete which saves you the work of mixing it yourself.

Details of foundation walls: The upper edge of the added wall should come flush with the house wall. Allow for suitable vent openings. Such openings are framed in the forms if the walls are of poured concrete. You install %-in. anchor bolts, from 12 to 20 in. long, so the thread ends will project above the wall to hold the siUs or sole

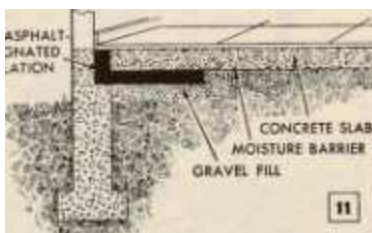


ta & Ontario Paper Co.

RIGID, ASPHALT-,

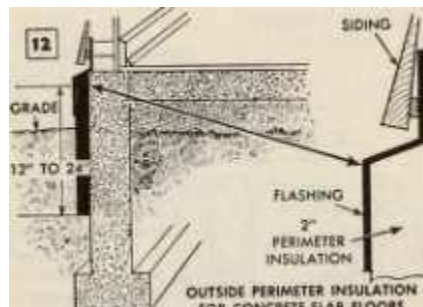
IMPREGNATED

INSULATION



CONCRETE SLAB MOISTURE BARRIER m, GRAVEL FILL

PERIMETER INSULATION FOR CONCRETE-SLAB FLOORS



OUTSIDE PERIMETER INSULATION FOR CONCRETE-SLAB FLOORS

plates of the walls. The bolts are spaced from 6 to 8 ft. apart, starting near corners as shown in Fig. 13. They are held in position in the forms while pouring the concrete, by means of wood crosspieces laid across the forms as shown in Fig. 5-F. The bolts should project about 3 in. above the top of the wall for a single-thickness sole plate or sill, and $1\frac{1}{2}$ in. for one of double thickness.

In a wall of concrete blocks, anchor bolts are similarly used. The mortar or concrete in which the bolts are imbedded is supported underneath by pieces of sheet metal inserted between the second and third courses from the top. In this case the bolts should be at least 16 in. long so that they will extend below the first course and possibly below the second. Fig. 10 shows a concrete-block foundation wall being coated with white waterproofing paint.

Concrete slab floors: Where a crawl space under an added room is not desired, and the floor level is just a little above grade level, you can have a concrete slab floor. This is generally 4 or 5 in. thick, and may be laid as soon as the foundation forms can be removed. Sometimes it can be laid integrally with shallow walls.

The earth around and under a slab floor should be well drained. It should be compact since loose earth or fill will settle and no longer support the slab. A 4-in. layer of coarse gravel, crushed stone or broken clay tile is spread on the compacted earth as indicated in Fig. 11. Cinders should not be used as these deteriorate. If gravel is used the "fines" are removed to prevent upward movement of water by capillary attraction. The gravel is tamped down firmly. Along the inside edges of the walls it should be 2 in. lower than elsewhere to accommodate perimeter insulation necessary in localities subject to frost.

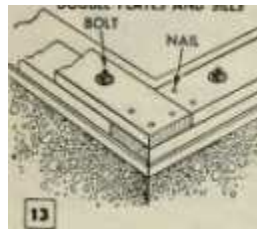
Perimeter insulation: This prevents floors along walls from becoming cold and being subject to condensation of moisture. Rigid, asphalt-impregnated insulation, which is waterproof, is made for this purpose. It should be 2 in. thick or may consist of two 1-in. thicknesses. Extend the insulation along the entire inside edge of the foundation as shown in Figs. 11 and 14. Set strips on edge along the wall, then lay others horizontally to

a 24-in. width.

Cover the gravel fill with strips of 55-lb. asphalt-saturated felt such as roll roofing. Overlap the edges 4 to 6 in., and seal them with roofing cement. After placing a Vz by 4-in. strip of resilient expansion-joint material where the new floor joins the house wall, as indicated in Fig. 14, you lay the concrete. Place welded wire-mesh reinforcing (40-lb. size) midway in the concrete while laying it.

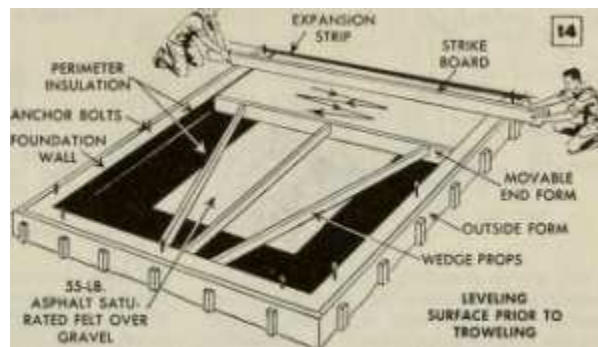
To insulate an existing concrete slab floor such as a floor of a porch that is to be enclosed, apply 2-in. perimeter insulation on

CORNER OVERLAP OF DOUBLE PLATES AND SILLS BOLT



PERIMETER INSULATION

ANCHOR BOLTS



55-LB, ASPHALT SATURATED FELT OVER GRAVEL

LEVELING

SURFACE PRIOR TO

TROWELING

the outside of the foundation as shown in Fig. 12. It should extend downward from 12 to 24 in., depending on the severity of frost. The exposed portion above grade can be protected and concealed with sheet-metal flashing, preferably aluminum.

Laying concrete slab floors: For slab floors you use a 1 : 2y4 : 3 mix. The floor is laid and finished in sections as shown in Fig. 14, for which a movable end form, held in position

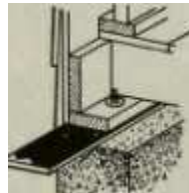
with wedge props, is used. The concrete surface is leveled with a "strike board." This is laid across the forms at the edges and is worked back and forth with a saw-like motion while progressing. For a smooth finish, the surface of the concrete is troweled with a steel trowel as shown in Fig. 15, just after the water sheen on the surface has disappeared. Avoid over-troweling as this results in surfaces that dust and craze readily. For a rough surface you use a wood float.

Uncovering the house wall: Now you can uncover part of the house wall, as shown in Fig. 10. You can remove both the wall covering and the sheathing at this time, or you can leave most of the sheathing intact until you are ready to attach the wall frames of the extension.

With the aid of a plumb bob you mark a vertical line on the house wall, in line with the outside edge of the foundation of the extension. If the house is covered with siding, you saw through this and also through the sheathing. If the line comes over a stud, saw on the side toward the portion of the wall covering to be removed. If the wall is shingled, remove these to the first joints outside of the lines, away from the added wall as shown in Fig. 10. On a brick-veneer house, the opening is made to the first brick joints outside of the lines, which would be about V_2 and AV_2 in. on alternate courses.

Attaching sills or sole plates: Carefully examine the house framing just above the foundation. It may have a single or a dou-

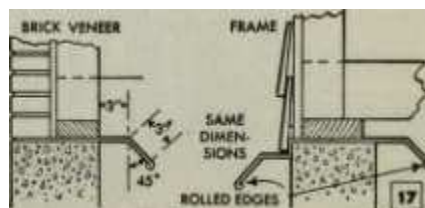
urtesy Portland Cement Assn.



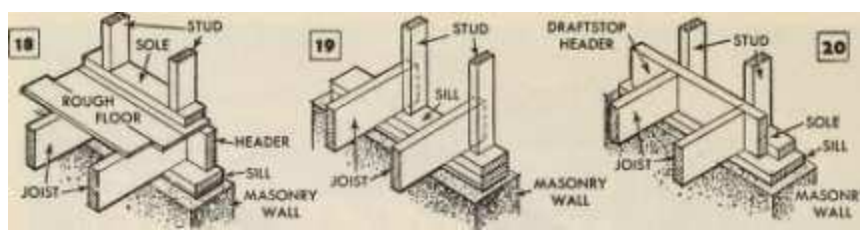
RESILIENT SILL-SEALING STRIP

16

BRICK VENEER



ROLLED EDGES TERMITE SHIELDS 28-GA. SHEET METAL



JOIST

BOX SILL

BALLOON-TYPE SILL

T-TYPE SILL

courtesy U. S. Federal Security Aye

of Education

ble sill, which should be duplicated on the extension. Also notice the type of sill construction and the width of the floor joists. Bore the sills or sole plates to fit the anchor bolts. The sills are set back from the outer edge of the foundation a distance equal to the thickness of the sheathing. For brick-veneer construction, they are set back a distance equal to the width of the bricks plus that of the sheathing unless the foundation is stepped for the brickwork. In case of concrete slab floors the sole plates of the walls are anchored to the foundation.

Tight foundation joint: Seal the joints between sills or sole plates and the foundation to prevent air leakage. You can use mortar spread on the foundation, pressing the sill on it and tightening the anchor bolts just enough to keep the sill level at the right height. A y2-in. sill-sealing strip of resilient, asphalt-saturated material. Fig. 16, is preferable to mortar. This also conforms to irregularities of the foundation.

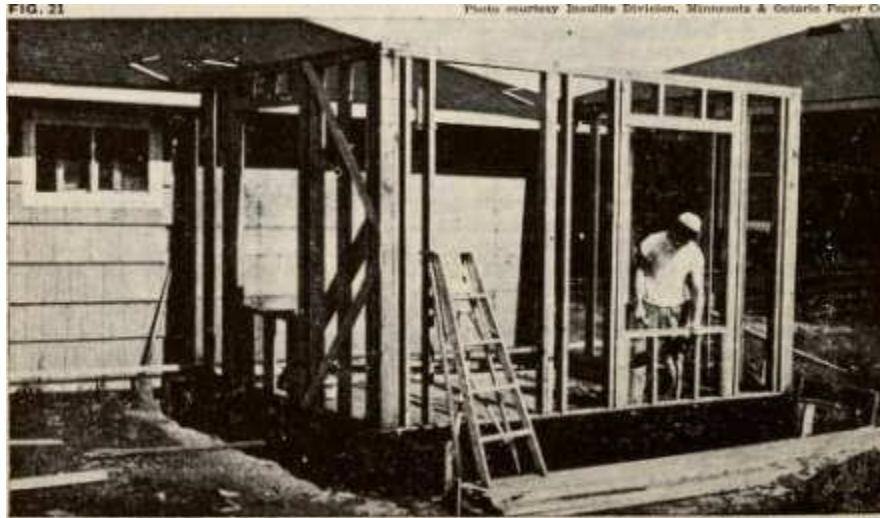
Termite shields: In localities where termites are troublesome, you install sheet-metal shields between the foundation wall and the sills or sole plates as shown in Fig.

17. The shields extend horizontally from the wall and downward at a 45-deg. angle. The exposed edges should be rolled as a safety precaution.

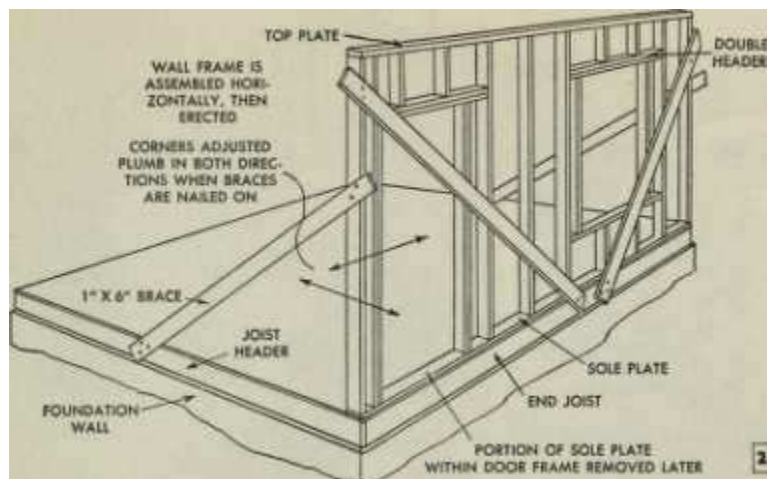
Joists and bridging: When sills are laid in a mortar seal, allow 24 hrs. for this to harden before installing joists. Mark the joist locations at 16-in. centers on sills of opposite walls. The joists should be the same width as those of the house so the floors will come flush. For box-sill construction, Fig. 18, you nail headers to joists with 16-d. nails. Also toenail the joists and headers to the sills with 10-d. nails, spaced about 16 in. apart. Headers are not used in the "balloon" type of sill construction. Fig. 19, in which case the joists come almost to the outer edge of the sills. The joists are toenailed to the sills and the studs are

nailed to joists and to sills. In T-sill construction, Fig. 20, a header is placed between joists and studs. If joists have a span of 10 ft. or more you need bridging to add stillness to a floor.

sota & Ontario Paper Co.



WALL FRAME IS ASSEMBLED HORIZONTALLY, THEN ERECTED
CORNERS ADJUSTED
PLUMB IN BOTH DIRECTIONS WHEN BRACES
ARE NAILED ON



FOUNDATION WALL

Floor insulation and vapor barrier: If the

space below the floor is unheated and is ventilated, you will need insulation and a vapor barrier where cold weather is experienced. Most batt-type insulation is combined with a

vapor-barrier covering, and has a projecting edge to facilitate nailing it to joists.

Subfloor: In box-sill construction, you lay the subfloor before erecting the wall frames. A subfloor may be laid across the joists at right angles, or diagonally at 45 deg., which provides greater rigidity. Details on laying subfloors are given in Section 16.

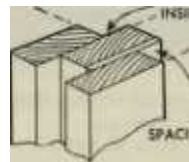
Erection of wall frames: Wall frames of an added room are shown erected in Fig. 21. First make the frame for the wall that is parallel to the house wall. Preassemble the frame in a horizontal position, spacing studs 16 in. on centers and end-nailing them through the plates with 16-d. nails, two at each end. Then swing the assembled frame into place, adjust it plumb in both directions and attach braces to hold it in this position as shown in Fig. 22. After erection, the sole plate is fastened down with 16-d. nails driven into the floor framing. The supporting braces are not removed until the frame is joined to others.

The corners of wall frames should provide nailing bases for both inside and outside wall coverings. Two types of corners so planned are shown in Fig. 23. Extra rigidity for wall framing at corners is provided with diagonal bracing of 1 by 6-in. stock mortised into and nailed to the studs as shown in Fig. 24.

Cutting back at eaves: Before erecting the side-wall frames, remove the roof gut-

SOLE PLATE END JOIST

PORTION OF SOLE PLATE WITHIN DOOR FRAME REMOVED LATER



∴ INSIDE CORNERS

SPACING BLOCK^ CORNER CONSTRUCTION

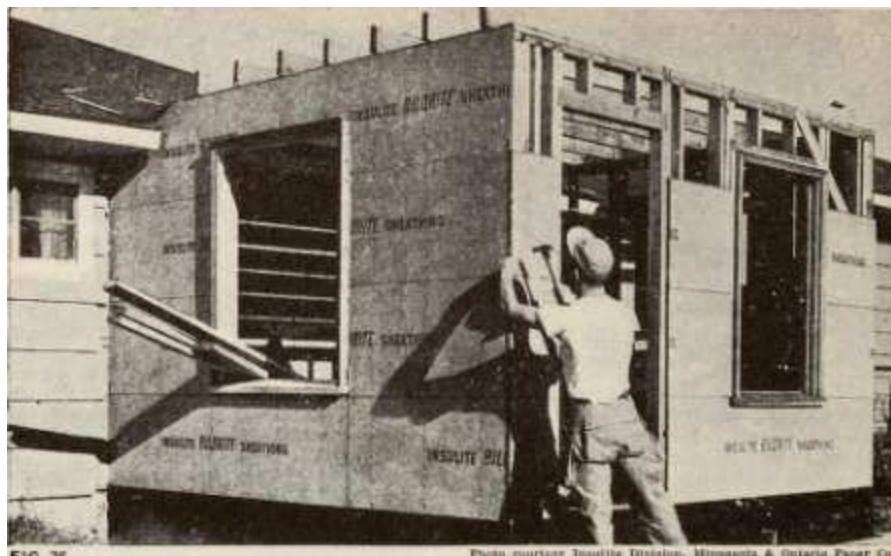
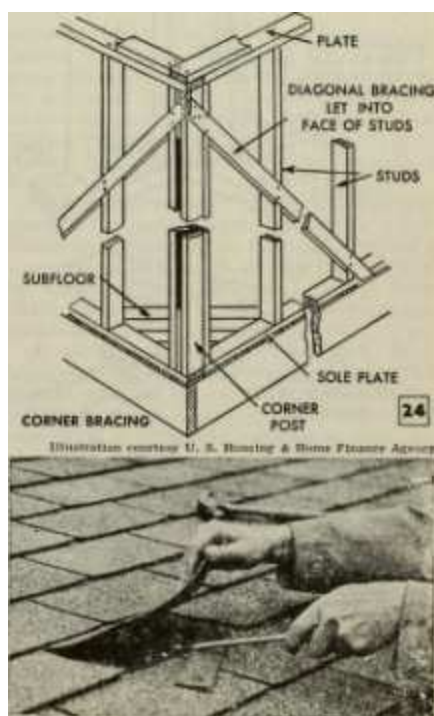


DIAGONAL BRACING

LET INTO

FACE OF STUDS

STUDS



rtcsy Insulite Division, Minnesota & Ontario Paper Co.

CONCEALED STUD

DISTANCE FROM CUT TO STUD EQUALS THICKNESS i OF SHEATHING j [

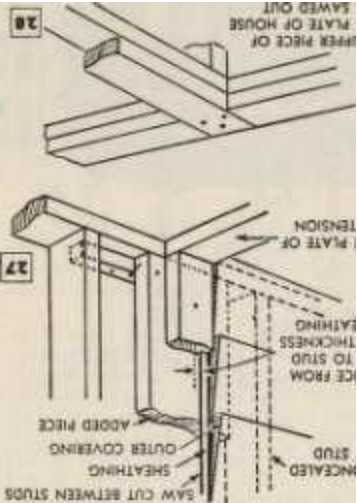
SAW CUT BETWEEN STUDS .SHEATHING OUTER COVERING ADDED PIECE

SOLE PLATE OF-^s EXTENSION

UPPER PIECE OF

TOP PLATE OF HOUSE

SAWED OUT



ter, some roof shingles, and cut the eaves back to the wall framing of the house. Projecting rafters are cut off flush with the top plate of the house wall. Asphalt shingle strips are relatively easy to remove without damaging them as shown in Fig. 25. On wood shingles it is necessary to cut the nails instead of prying them out. Section 6 includes methods of removing shingles. As the opened roof allows rain to get inside, which may cause damage, use a waterproof tarpaulin to cover the opening,

Joining side-wall frames to house: Where a side wall of an extension is a continuation of a house wall, you nail the last stud to the corner framing of the house. Should the opposite side wall come directly over a stud in the house wall, it is similarly nailed to it. Where the wall of an extension joins the house wall at a location between studs as in Fig. 27, a 2-in. upright, 6 or 8 in. wide, is inserted in the house wall, which provides a nailing base for the inside and outside wall coverings. Next, you nail on extra top plates. These join the house wall as shown in Fig. 28, and are overlapped at corners as shown in Fig. 24.

Wall sheathing and roofing: Install window and door casings and then cover the wall framing with sheathing as shown in Fig. 26. Installation of window and door casings, and the application of sheathing, can be done after the roofing has been completed. Sheathing and siding carefully removed from the house can be used to cover part of the extension usually. Ceiling joists and the roof framing are then added as shown in Fig. 29, nailing the rafters to the ceiling joists and also toenailing them to the top plate. Next, you apply the roof sheathing, roofing felt, flashing and shingles. Then it is usually advisable to add a vent in the top of a gable or in the roof besides one at the cornice of an added roof to assure adequate ventilation in the space between the ceiling and roof.

Wall and ceiling insulation: Outside walls and ceiling are then thoroughly insulated, using Batt-type insulation which is tacked



or stapled to the inside surfaces of the studs and ceiling joists after the wiring has been installed. The vapor-barrier side of the insulation should always face the inside of the house.

Finishing details: Wood sheathing is covered with building paper before applying the outside covering such as siding or shingles. Siding is nailed on in such a way that the nails enter studs. Shingles are nailed directly to wood sheathing and in some cases directly to insulating-board sheathing by means of special self-clinching nails. Generally, however, shingles applied over insulating sheathing require horizontal furring strips as a nailing base.

Before finishing the inside, a doorway between the house and the added room must be provided. Also, an existing window may have to be removed. If window opening is located where a door is wanted, you merely increase the height of the opening and change its width as may be necessary.

For interior walls you can use any of the various wallboards which come in the form of panels or planking this dry-wall construction. You can also have the walls plastered, which is sometimes preferred, to match existing walls in the adjoining room. The trim is applied last.

Extensions on two-story houses: In adding a two-story extension to a house, the same general methods of procedure are followed as already described for a single-story addition. Adequate ventilation should be provided for an extended attic and it should be made accessible. Insulation then is installed over the second-floor ceiling as it is not needed between the first and second floors.

Attached garages: In building an attached garage, the same general procedure is followed as in building an extension having a concrete slab floor. A garage floor should be sloped

slightly toward a center floor drain connecting to the house drainage system.

A ventilated passageway such as a breezeway should be provided between the garage and the house. This prevents the entrance of car fumes into the house and also helps to minimize tracking in dirt. An overhead garage door with compensating springs is convenient to use and is relatively easy to install, following the instructions such as are generally furnished by manufacturers.

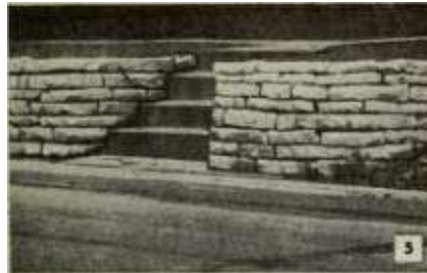
Before building an attached garage it is highly important to investigate local building codes. These often call for special fireproof construction as, for example, a metal-covered door between the garage and the house. A garage ceiling may be brought to come flush with the first-floor ceiling. If suitable joists are used, an extra room can be built above.

RETAINING WALLS

SLOPING LAWNS often can be given a much better appearance by edging them with easily built retaining walls of stone or concrete. On lawns having steep banks, which make them subject to fast erosion and also difficult to cut, retaining walls afford the additional advantages of reducing erosion and simplifying maintenance considerably.

Many applications: Fig. 1 shows how a low flagstone retaining wall is used to obtain two level terraces instead of a sharp drop in grading across the front of a house. Note how the wall pictured in Fig. 2 eliminates a steep bank along an entrance drive and front sidewalk. Fig. 3 shows a retaining wall which is used to protect an old, valuable tree where the grade all around the tree was lowered to blend in with street paving. Foundation terraces. Fig. 4, which often are used to enclose flowers or shrubs, are particularly desirable where a house is set on a high foundation. The terrace and its plantings give a lower, more modern appearance to the house. Another application is to separate adjoining lots with a low retaining wall to make each one more nearly level. A lawn having a pronounced slope may be divided similarly into several level or slightly sloping terraces.

Drainage and frost precautions: Lack of good drainage and damage from frost can ruin a good retaining wall within a few years. Walls built of loose flagstones automatically provide drainage through the joints, Fig. 6, detail B. However, a solid wall holds water behind it and requires drain tile along the base on the inside of the wall as in detail C. The tile is led to a lower location, such as a dry well or a sewer. Even with proper drainage provided, soil frequently holds enough moisture by capillary attraction to permit some expansion by frost. Loose-stone walls have sufficient flexibility to move with the soil upon freezing and thawing. For example, the one pictured in Fig. 5 has kept its original shape and position for 17 years in a climate where alternate freezing and thawing occur frequently during winter. To withstand lateral pressure of freezing soil, solid walls



FUT, STRAIGHT EDGES

PN FACE OF WALL

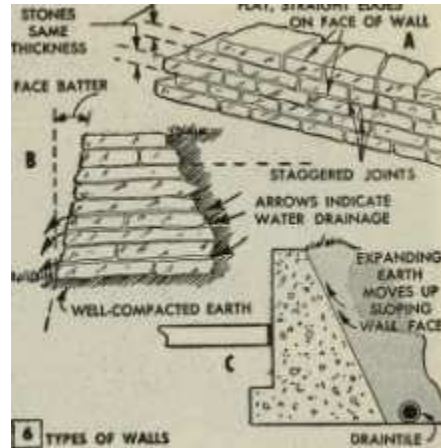
A

should be built much wider at the base than at the top, as in detail C, the inner side sloping acutely. This side, if smooth, will further help to relieve lateral pressure as it will allow freezing ground to shp upwards as it expands.

Loose-flagstone walls: Retaining walls of flagstone, built loosely without mortar, are the easiest to construct. Start by laying the stones on undisturbed earth rather than on loose fill which will settle. The stones of each course should be of relatively equal thickness, as in Fig. 6, detail A, to keep the wall level. However, for variation, a few stones the thickness of two or three courses may be placed in the wall at random. Set the stones so that straight, flat edges will be exposed.

When it becomes necessary to chip a stone to get a straight edge, use a cold dhisel and a hammer. The basic idea of fracturing stone is quite similar to glass cutting. First score a guide line on each side, one directly over the other, by running the chisel along a straight edge. Next, nick both edges about Vs in. deep to connect the scored Unes. Then lay the

stone flat on the ground and tap it with the hammer and chisel to make the score lines about 1/8 in. deep. After thus deepening the score lines continuously, tap with sharper blows from the center toward the edges. If this is done care-



I TYPES OF WALLS

DRAINTILE ■

fully, the stone will fracture straight across like the one shown in Fig. 7. This can be accomplished in just a few minutes. Scoring confines the fracture where it is wanted and tapping weakens the stone. Don't try to make a straight break with a few heavy blows, as the line of fracture cannot then be controlled.

Joints between stones in any course should be bridged by stones of the course above, in the manner that bricks and shingles are laid. It also is best to lay the stones either level or at a very slight forward pitch for proper drainage. If the face of a wall is vertical it will appear to lean forward, this illusion becoming more apparent if the wall is higher than 3 ft. Therefore, on walls over a foot high the face should be given some inclination or "face batter," varying from 1 to 4 in., or even more, per foot of height.

The width of a loose-stone wall may be as little as 8 in. if the wall does not exceed a height of 1 ft. A 10 to 12-in. width is better for a wall 2 ft. high, and a 12 to 16-in. width for a 3 or 4-ft. wall. Spread some soil over each course to "bed" the next course. This also permits creeping rock-garden plants to take root and spread. The plants will keep the soil from washing out of the crevices during heavy rains. In many cases foliage adds to the over-all appearance of a retaining wall.

Solid-masonry walls: Solid retaining walls higher than 3 ft. generally are built of concrete, as pictured in Fig. 8. If a brick or stone facing is desired this can be added. Fig. 9, detail A, shows a cross section of a properly designed concrete wall. The base should extend just below the point to which frost penetrates, and it should be poured on firm, undisturbed earth. If the excavation

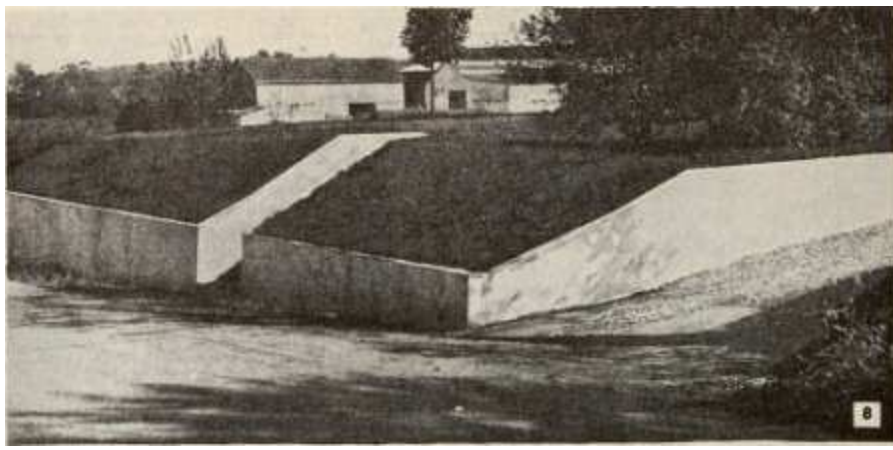


Photo courtesy Portland Cement Association

is accidentally carried too low, don't fill

with earth but increase the depth of the wall instead. Lay drain tile at the inside of the wall at base level as in details A and B. Butt the tile together and provide a slight drainage pitch. The latter can be checked with a level. Then put a 4-in.-wide strip of tar paper over each joint, detail C, to prevent earth from falling inside the tile. Finally, cover the tile with a 12-in. layer of gravel or crushed stone.

Walls less than 5 ft. high should have a minimum top thickness of 5 in., while those over 5 ft. high should have a top at least 8 in. thick. The base width of a solid-masonry retaining wall should be approximately $\frac{1}{2}$ of the wall height. Thus, the bases of walls 3, 4, 6 and 8 ft. high should be 2, $2\sqrt{2}$, 4 and $4\sqrt{2}$ ft. wide respectively. As in the case of the stone walls, face batter of $\frac{1}{4}$ in. or more per foot of height is desired so that the face will not appear to lean outward.

Large retaining walls of concrete are major undertakings and should be built by concrete contractors. However, the average homeowner can build forms for small retaining walls as in Fig. 9, detail D. Get ready-mixed concrete if you can, to eliminate the backbreaking labor of mixing by hand. If you mix your own concrete, use a mix consisting of 1 part portland cement, 2¹/₄ parts of clean, sharp sand and 4 parts of gravel or crushed stone, the latter being no larger than $\frac{1}{2}$ in. in diameter. After these ingredients have been well mixed, add $6\frac{1}{4}$ gal. of clean water per sack of cement if the sand is damp; $5\frac{1}{2}$ gal. if it is wet. Keep the forms soaked with water for a week after pouring the concrete so it can cure slowly to attain maximum strength.

• • •

FACE BATTER $\frac{1}{4}$ " PER FT. OF HEIGHT

✓" PLYWOOD OR 1" BOARDS

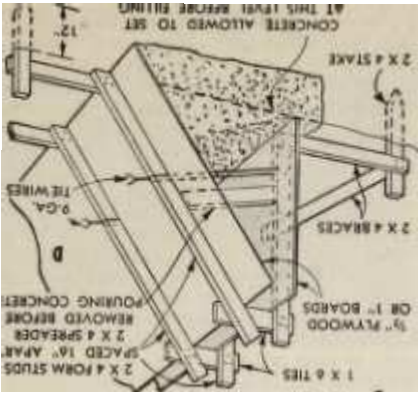
4" STRIPS TAR PAPER OVER JOINTS

2X4 FORM STUDS

SPACED 16" APART

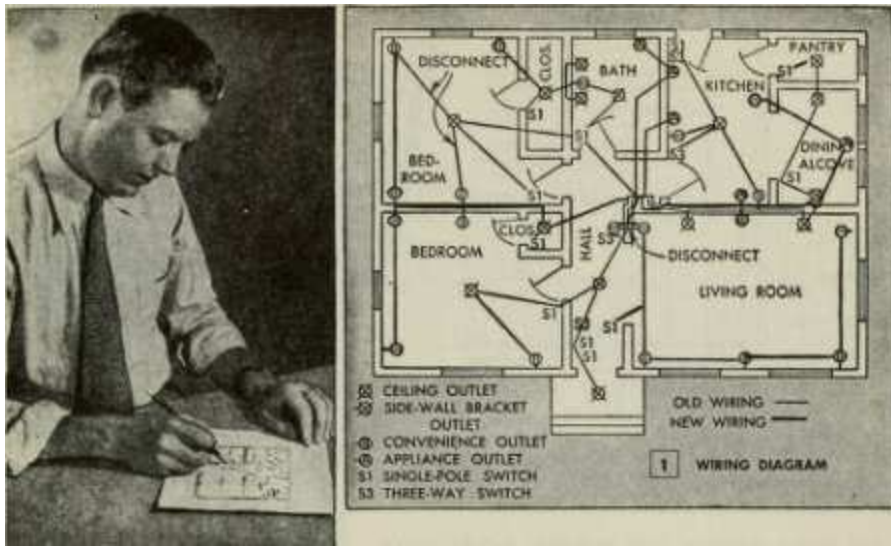
2X4 SPREADER

REMOVED BEFORE POURING CONCRETE



CONCRETE ALLOWED TO SET.

AT THIS LEVEL BEFORE FILLING "✓".



REWIRE YOUR HOME

If your home is more than 10 years old, it probably is not wired adequately to enable you to enjoy fully the convenience of modern electrical appliances

OLDER homes usually are not wired to make full use of all electrical conveniences now available or being developed. In many houses, the wiring is not of approved sizes to carry modern appliance loads; there are too few switches for control of the lights and an insufficient number of convenience outlets. Rewiring a home to take care of present and possible future requirements is quite simple to do. While most localities have no regulations prohibiting a homeowner from doing his own wiring, it generally is required that the completed job be inspected by a competent electrician for compliance with both the national and local electrical codes. Therefore, before going ahead with a wiring job, the homeowner should study all the local ordinances and codes and should be familiar with the requirements of the national electrical code.

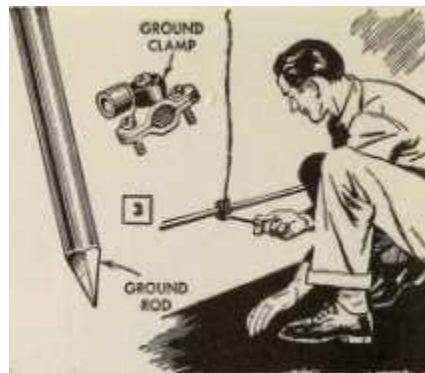
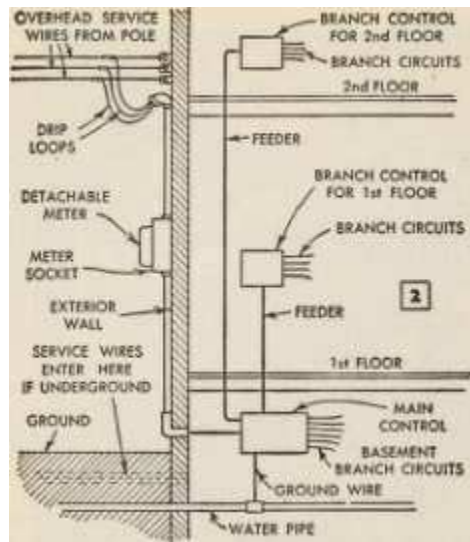
A rewiring job requires careful planning, so the first thing to do is make rough pencil sketches of the present wiring, as shown in black lines on the wiring diagram. Fig. 1. Make a separate diagram for each floor of

the house. If there is a garage or other building wired for electricity, include this on the ground-floor sketch. On each sketch, simply mark the approximate location of each lighting fixture, wall switch, convenience outlet, etc. Next, make pencil notes of the various conveniences and appliances desired. Among those that may be needed are fluorescent lighting, combination receptacles for radio power, aerial and ground. Fig. 4, and switches that permit lights to be turned on and off from any entrance to a room or from the top or bottom of a stairway. Other modern conveniences include door switches in all clothes closets. Fig. 5, that turn on the lights when the doors are opened, and outlets that provide plug-in receptacles easily reached from any part of the room. Locate separate outlets for the kitchen clock, mantel clock, electric iron, washing machine, dishwasher, garbage-disposal unit and a ventilating fan. Any other special lighting problems should be considered and provided for in the rough plan.

If wires are not large enough to handle maximum current requirements, lights and appliances will not deliver their rated output. The national code recommends No. 12 wire as the smallest size to be used on branch circuits. Furthermore, the code specifies that wiring capacity be sufficient to provide at least 2 watts of lighting for every square foot of floor area in the house,

OVERHEAD SERVICE WIRES FROM POLE

BRANCH CONTROL FOR 2nd FLOOR



-.^7^:^^

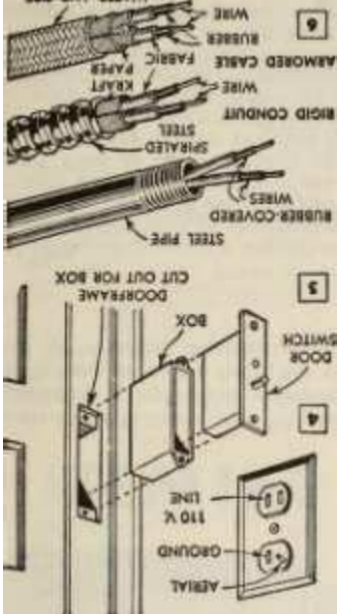
excluding unfinished areas such as the basement and attic unless these require special lighting.

In addition to lighting requirements, capacity for 1500 watts of appliance load must be provided on circuits separate from the lighting and convenience-receptacle circuits. Appliance circuits usually are provided for the kitchen, dining room, utility room and laundry, or whichever of these are on the floor plan. If a total of more than six receptacles is required in these locations, two or more circuits are provided. When planning appliance circuits, remember that other heavy-load appliances such as a home freezer, clothes drier and perhaps a room-type air conditioner may be added in the future. If you are considering these extra units, plan one or more extra circuits or provide sufficient

capacity in the branch control center and feeders to take care of the requirements.

In deciding on the location of convenience outlets and circuits, the following suggestions may be helpful as they follow approved procedure: Place a receptacle in each usable wall space 3 ft. or more in width. Have a receptacle located within 6 ft. (at the floor line) of any location in any usable wall space. Provide receptacles on enclosed porches. All outdoor receptacles must be of the weatherproof type. Receptacles for television sets should be located so that the set can be placed where light from windows will not strike the screen directly. Place at least one receptacle at each work space in the kitchen, workshop, garage and utility room. Locate separate receptacles for fixed appliances such as the garbage eliminator, dishwasher, ventilating fan and bathroom heater. Workshop motors should be on the

Grounding of neutral wire at service entrance is accomplished by connecting to water pipe with clamp shown above. If water pipe is not available, ground wire is connected to rod driven into ground



RIGID CONDUIT

WIRE; ARMORED CABLE FABRIC

RUBBER WIRE SHEATHED CABU

WATER AND FIRE-PROOF BRAID

CURRENT CAPACITIES OF WIRES

Size !!»

14-15 amperes 4-70 ampei

12-20 " 3-80

10-30 " • 2-95 8-40 " 1-110 '

6-55 " .

These are Code capacities. The size used throughout this article is larger to compensate for voltage drop. Designers use one size larger than table

FEEDERS TO

2nd.FLOOR

BRANCH CONTROL

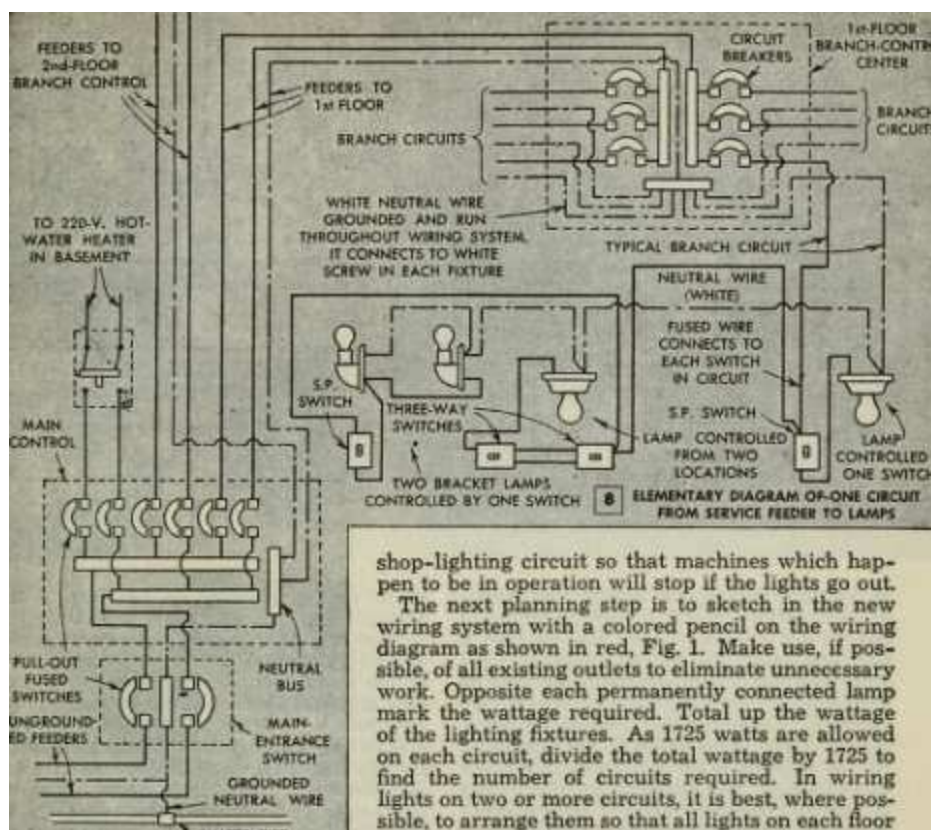
TO 220-V. HOT-WATER HEATER IN BASEMENT

"cVcUiri I'^-f^LOOR

BREAKERS j^ ^^CH-CONTROL

K3 D-

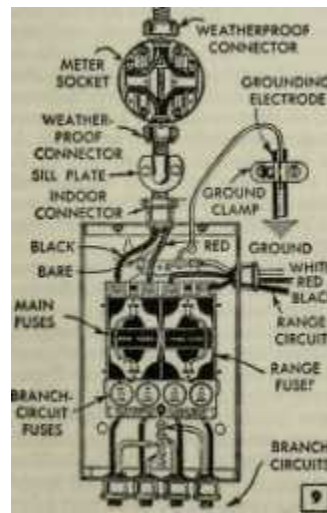
CENTER



LAMP CONTROL IE^T—I LAMP

FROM TWO • B CONTROLLED BY LCXATIONS t_J ONE SWITCH EtEMENTARY DIAGRAM OF-ONE CIRCUIT FROM SERVICE FEEDER TO LAMPS

^-WATER PIPE



shop-lighting circuit so that machines which happen to be in operation will stop if the lights go out.

The next planning step is to sketch in the new wiring system with a colored pencil on the wiring diagram as shown in red, Fig. 1. Make use, if possible, of all existing outlets to eliminate unnecessary work. Opposite each permanently connected lamp mark the wattage required. Total up the wattage of the lighting fixtures. As 1725 watts are allowed on each circuit, divide the total wattage by 1725 to find the number of circuits required. In wiring lights on two or more circuits, it is best, where possible, to arrange them so that all lights on each floor are not on one circuit. Otherwise, the blowing of a fuse will cause all the lights on that floor to go out. To figure the number of receptacle circuits required (other than the special ones feeding kitchen, laundry, etc.) allow one circuit for each six or seven receptacles. As in Fig. 2, it is best to provide a branch control center for each floor in the house. These branch control centers are fed from a main control center located near the point where the service feeder from the power lines enters the house.

When the number of lighting and convenience-receptacle circuits have been calculated for each floor, mark this information on the sketch. Branch circuits should be of No. 12 wire, each circuit being rated at 15 amp. The rated amperage of all the circuits in a branch control center added together will give the total amperage required for that control center. This will apply where two-wire feeders are used between the branch control centers and the main control center. However, three-wire service lately has come into common use in new installations. With three-wire feeders, the amperage will be halved. The correct size of wire required for each branch feeder can be determined easily from the table in Fig. 7. The feeder circuits remaining to be calculated are the individual branch circuits

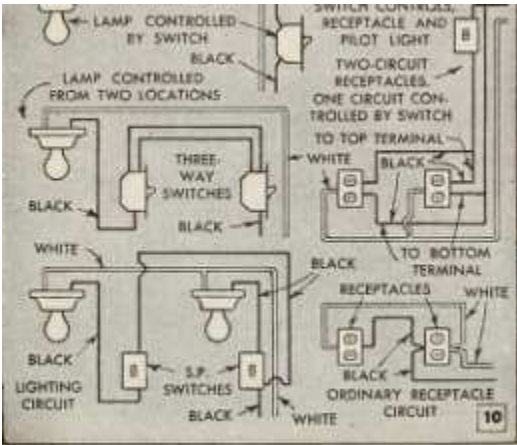
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WHITE WIRE TO WHITE TERMINAL

WHITE" COMBINATION RECEPTACLE.

SWITCH CONTROLS, LAMP CONTROLLED --^ II ^—j RECEPTACLE AND | BY SWITCH
*< ? PILOT LIGHT

BLACK ^ Sv_j TWO-CIRCUIT LAMP CONTROLLED]H RECEPTACLES.



OUTLET-BOX EXTENSION

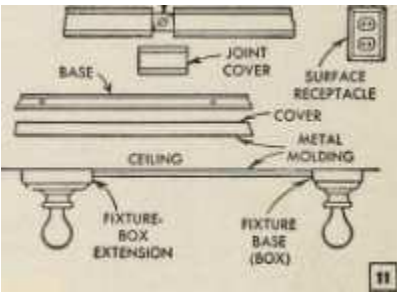
ELBOW FITTING

WHITE \ SURFACE CONDUIT BLACK

^



CLAMP-COUPLING TYPE SUPPORT AND FASTENER



which feed directly to heavy-load appliances such as a water heater or range. If the power company does not require a separate meter on the water-heater circuit, both the heater and the range may be connected to the same branch circuit. To calculate the size of the feeders required, simply divide the wattage of each appliance by the voltage. This will give the amperage required. For example, a water heater consuming 3000 watts at 230 volts will require 13 amp. (3000 divided by 230). Use No. 10 wire for this load. The range load is calculated in the same manner. While ranges usually operate on both 115 and 230 volts, depending upon how many burners are in use at a time, only the 230 voltage is used to calculate the amperage. For a range rated at 7000 watts, the load would be 30.4 amp. Use a three-wire feeder of No. 16 wire.

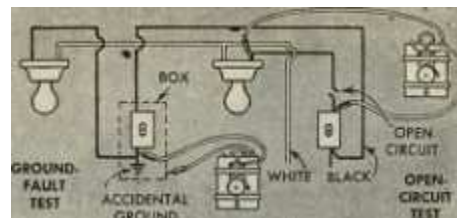
Branch control centers may be arranged in three ways. They may consist of only 15-amp. circuits for lamps and convenience receptacles. Secondly, they may contain one or more 15-amp. circuits and one or more 20-amp. appliance circuits. Or, they may contain only 20-amp. circuits. A fuse or circuit breaker protects each circuit, but the fuse or breaker must be of no greater capacity than the circuit. The main control center will contain two fuses or a double-pole circuit breaker for each feeder from the branch control center and for each feeder from the appliance branch-circuit feeder where three-wire feeders are used. These overload devices must have a rating no higher than the carrying capacity of the wires they feed. If two-wire feeders are

used, only one fuse is required. The grounded wire. Fig. 3, is not fused.

After the calculations have been made, mark this information on the rough sketch of the circuits and control centers of the new system. The installation of new conduit runs is not difficult. Some local codes permit only thin-wall conduit to be used in certain locations. Check before making the installation. In all conduit work, whether using rigid or flexible metal conduit. Fig. 6, the structure of the house determines to some extent the procedure to be followed. Usually, there is a way to feed flexible conduit either through or around ordinary obstructions, but sometimes it will be found impossible to run conduit to certain locations. Such outlets may have to be relocated or surface conduit, called metal molding, may have to be used as in Fig. 11. A suitable box should be installed in the basement or

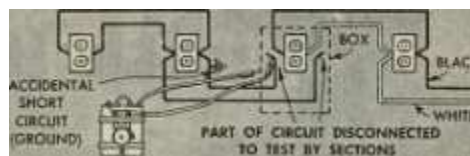
utility room to contain the doorbell transformer, which should be connected to a branch lighting circuit and protected with fuses.

Of course, rewiring an old house is more involved than wiring a new one. Service will have to be maintained to some lights while other circuits are being installed. Start by installing the service-entrance wires and equipment, as shown in Figs. 8 and 9. The service switch shown in Fig. 9 is ideal for a house utility room where all the rooms are on one floor. Next, run the branch-circuit feeders and the individual appliance circuits. The latter should terminate in suitable receptacles or switch boxes to which the appliances are to be connected. Follow this by removing all the



OPEN > CIRCUIT

WHITE BLACK' OPEN-ORCUIT TEST



BOX-M^

existing wires from one circuit at a time and installing new, larger-capacity wires. Where armored cable, nonmetallic cable or knob-and-tube wiring is to be replaced, remove all the old wiring. Next, fish in the new armored cable or flexible metal conduit and attach to the boxes. Larger-capacity armored cable may be installed, or three-wire armored cable substituted and the outlets divided evenly between the two circuits.

If rigid conduit is merely to be rewired, pull out the old wires and replace them with larger-capacity wiring of the new S.N. type having a smaller diameter. This can only be used for rewiring of existing conduits or metal molding. Either the same number of wires of larger capacity can be used, or the circuit can be split into two parts and two circuits installed, using three or four wires of the same capacity. Where three-wire branch circuits are used, they must be considered as two separate circuits. Each ungrounded wire is protected at the branch control center by a single-pole breaker or by a fuse, Fig. 8.

As each circuit is completed and the connections made, it is tested and connected temporarily to the old distribution fuses. Figs. 8 and 10 show how various devices and fixtures are connected to circuits. In splicing wires in outlet boxes, solder the joints and cover with rubber tape and friction tape, or use approved solderless connectors. When all the new circuits are finished they may be disconnected from the old fuses and connected to the new branch control centers, or main control center, as the case may be. The feeders are then con-

^ - ^ WHITE PART OF CIRCUIT DISCONNECTED TO TEST BY SECTIONS

BLACK



CIRCUIT. > ^ WHITE CONTINUITY TEST

nected and the branch control centers are mounted in their proper location. Then the feeders are connected to the main control center, but all circuit breakers are left in open-circuit position until the feeders and circuits have been tested. To feed individual branch circuits, appliance circuits, feeders and service feeders, a simple test set is assembled from a doorbell, two dry cells and test prods as in Fig. 12. Fig. 13 shows how to test the various circuits.

If a ground shows up, check all boxes through which the circuit feeds for the cause of the trouble. It may be caused by the end of a bare wire touching some metal part of an outlet box, or the insulation may have been cut on a wire where it enters a box. If the defective circuit can be tested in sections, this may save considerable time in locating the trouble. The same general procedure is followed in searching for an open circuit, except that in the case of an open circuit a defective splice or broken wire usually is the cause of the fault. If all circuits test free of grounds and show complete circuit continuity, then test for ground continuity at each outlet. Sometimes paint will prevent a good ground connection between a box and the conduit or cable attached to it. To insure against defects in the wiring, be sure to tighten all wire-terminal screws, cable clamps, lock-nuts and bushings in boxes. Insulate splices carefully and use fiber bushings in the ends of flexible metal

cable. Fasten all switches, outlets and fixtures securely.



What to Make RIBBON

SPRING, winter or fall, it's the accessories that keynote the smart woman's wardrobe. Here is an easy and inexpensive way to add that flash of brilliance and variety to the most dependable of feminine possessions—the basic dress.

With a few yards of ribbon and some imagination, the simplest garment can be disguised and transformed for every occasion, such as adding this exciting stole pieced together with ribbons of your favorite colors.

What to Make RIBBON

Rainbow stole: As a suggestion, take 6 yd. of 1 1/2-in. red grosgrain ribbon; 4 yd. of 1-in. maize, 4 yd. of 1-in. royal blue and 4 yd. of 1-in. white, and cut the ribbons into 2-yd. lengths, giving you nine lengths of ribbon in all. Lap one length of the maize ribbon very slightly over one length of the red ribbon, and machine-stitch together—using yellow thread for the needle and red thread for the bobbin. Continue in this manner to lap each of the ribbons over the preceding one (red, maize, royal, white, red, white, royal, maize and red—in that color succession) and machine-stitch the lengths together, remembering always to use the same color thread in the needle as the ribbon on top and to thread the

bobbin with the color of the ribbon underneath. When the stole is complete, the center and two outer panels will be red, with the white, royal and maize leaving the center in that order. Fringe the stole 1 in. from each end, across the entire width. If the sewing is done by hand, use faggoting.

Ribbon dickey: To lend soft elegance to your suits, the ribbon dickey with its simplicity of detail (Fig. 2) is ideal. The materials needed are: One 46-in. strip of 2V8-in. grosgrain ribbon in gold . . . one 51-in. strip of 2%-in. grosgrain in brown . . . two spools of matching thread . . . two hooks and eyes . . . one small button ... 1 yd. of elastic string.

(A) Cut each strip of ribbon in half, making four strips in all.

(B) Take the two longest ribbons (brown in this case) and fold them over 7 in. from the top. Lay the two pieces of folded-over material side by side, overlap them Vs in. and stitch them from the bottom edge up

to the place where you meet the folded-over edges. Keep your stitches as close to the edge of the ribbons as possible. Then continue your stitches up both inner edges of the ribbon to the top, where the ribbons have been folded over.

(C) Stitch your remaining strips of ribbon, one on each side, to the two ribbons you have just stitched together, by overlapping the ribbons % in. at the bottom and Vs in. at the top.

(D) Hem the bottom by folding all four widths of ribbon twice, to a y4-in. hem, and sewing by hand. Fold the two ends of the outer ribbon over diagonally, making a hem, with the points toward the outside top. Sew hooks and eyes on these hemmed ends.

(E) Sew a small button on the outer edge, front of dickey, as shown. Double the elastic string, sewing together Vz in. from the doubled end, to form a button loop. Sew opposite ends of string firmly to hack of dickey, on side opposite button.

Two-color ribbon sash: To accent the grace of your full "waltzing skirt," add a glamorous ribbon sash of contrasting col-

ors, as in Fig. 3. The materials necessary are: 2[^]/4 yd. of 6%-in. nylon-taffeta ribbon and iy4 yd. of the same width in a contrasting color.

(A) Cut 1 yd. from the 2V4-yd. length of ribbon, and make a QVa-in. loop in it.

(B) Pleat and pin this loop.

(C) Pleat one end of the remaining l[^]A yd. of ribbon to a iy4-in. width. Finish the end with a narrow hem.

(D) Measure from the finished end to a comfortable waist measure and pleat and pin this

ribbon to the loop you have made. Stitch together. Allow remaining bit of ribbon to hang free.

(E) Take 1½ yd. of your contrasting ribbon, and pleat and fold it over the loop end, making the front portion about 5 in. shorter. Pin and slip-stitch these ribbons together. Then sew hooks and eyes on the waistline section and under the loop. Fringe the ends of the remaining sections and sew sequins or small flowers on the short end of the over-sash section.

Bow ascot: A large bow ascot, (Fig. 4), is not only comment-provoking, but also gives a pert, saucy flair to your sweaters and

B 1^i66<m T>u^



blouses. Try it with two ¼-yd. strips of ¼-in. nylon-taffeta ribbon in contrasting or harmonizing colors.

(A) Turn back the ends of each length of ribbon ½ in. and gather to a 1-in. width.

(B) Place one length of ribbon on top of the other.

(C) Gather to 1-in. width the places 12 in. from each end.

(D) Turn each end up on to the opposite color and slip-stitch it into place at the 12-in. shirrings.

(E) Pull the ascot around your neck to the center front or on one side, slip one end between the two colored ribbons just above the shirring, and adjust the loops.

Notched-wing ascot: For more formal trim, the notched-wing ascot in velvet and taffeta ribbon (Fig. 5) will make your suits more adaptable for after-five wear. This simple accessory only requires 1 yd. of 4V4-in. taflfeta ribbon and IVi yd. of %6-in. velvet ribbon in black or another contrasting color.

- (A) Cut pointed ends on a 32-in. length of the taffeta ribbon.
- (B) Slash one end of the ribbon dVz in. up the center.
- (C) Bind the slashed edges and both ends with the contrasting velvet ribbon.
- (D) Pleat the center of the ascot to a 3y2-in. width.

The ascot is worn by laying the large end over the split ends, as in detail E; bringing the lower half of the split end up over the top, as in detail F, and tying a knot, as in detail G.

You can develop a variety of styling possibilities from the foregoing patterns by varying the widths of your ribbons and the color combinations to suit your own individual taste.

There are unlimited accessories you can create yourself with ribbon—multicolored neckties . . . frilly peplums . . . aprons or capes designed with a series of ruffles . . . hair bands and chokers trimmed with flowers, etc. And for some undercover work, try adding a few layers of taffeta ribbon to the hems of your full slips for that "mysterious rustle" effect.

Certain information and sketclie

rtesy of Martin Fabri<'s Coip.



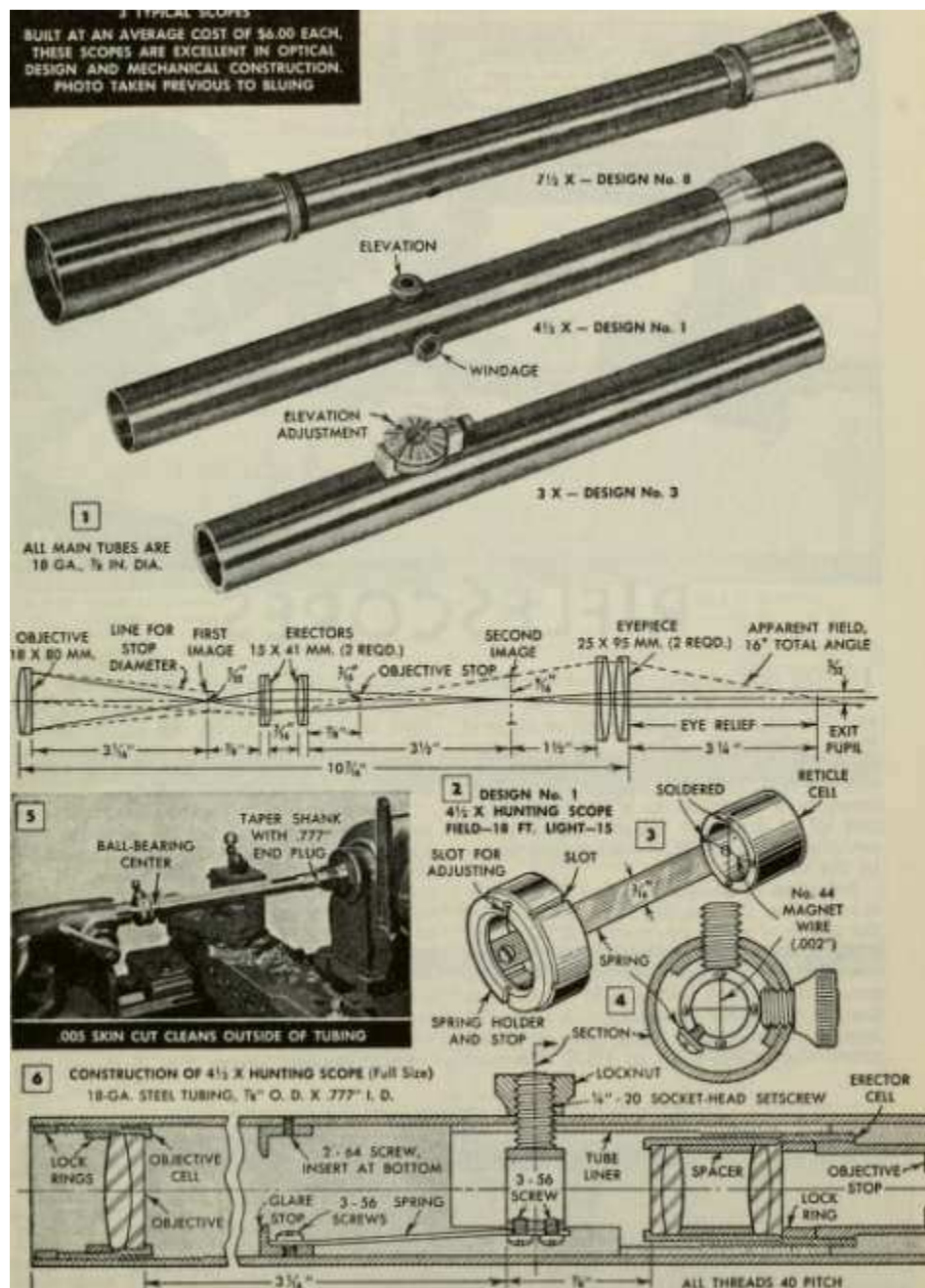
^aeci / ^4c^t

3 TYPICAL SCOPES

BUILT AT AN AVERAGE COST OF \$6.00 EACH

THESE SCOPES ARE EXCELLENT IN OPTICAL
DESIGN AND MECHANICAL CONSTRUCTION

PHOTO TAKEN PREVIOUS TO BLUING

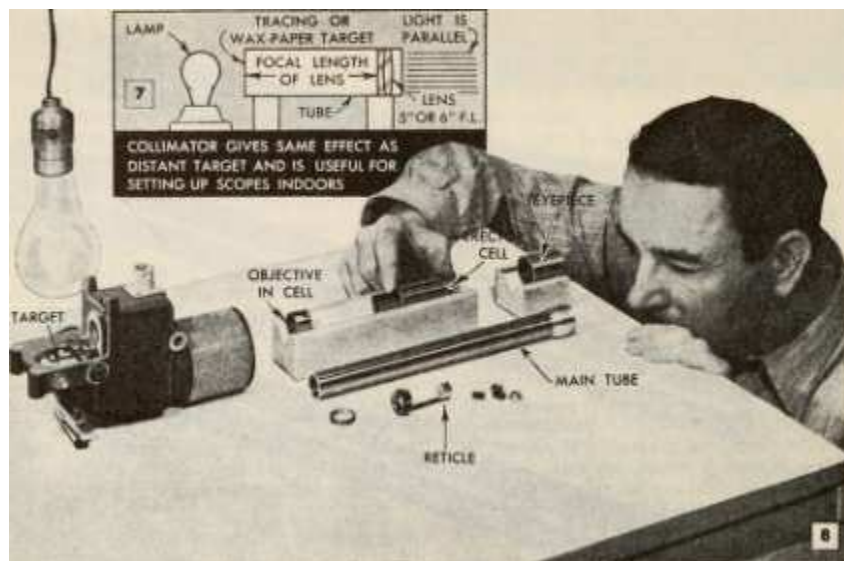


ALL THREADS 40 PITCH

MAIN TUBE 8'?"LONG

TRACING OR LIGHT IS

' WAX-PAPER TARGET PARALLEL^



RIFLESCOPES

IF YOU ARE a hunter and also like to run *■ a lathe, you will enjoy both the work and the results of building one or more of these riflescopes. Three typical scopes shown in Fig. 1 were built at an exceptionally low cost. The eight designs cover about everything required in a hunting scope, and all of them are bench-tested, representing the best of 40 jobs set up and tested by the author.

Selection of design: The first thing to do is to go over the spacing layouts and select the power of scope you prefer. If you want a big-game scope, the power should not be over 3X, as the important things here are good illumination and a field of not less than 28 ft. at a 100-yd. distance. A scope for small game should be 3X to 5X, a good all-round choice being 4X or 4y2X. Varmint

scopes can run to a little higher power, and designs Nos. 7 and 8 are excellent for this type of shooting. Order the lenses needed from any dealer handling stock lenses, as the ones used have been selected for availability as well as optical quality.

Tubing: Inside and outside diameters of various gauges of tubing are given in Fig. 11. The main tube of the scope should be 18 or 20-ga. seamless steel tubing, $\frac{1}{8}$ -in. o.d. (outside diameter). A .005-in. skin cut. Fig. 5, is used to clean up the outside of the tubing. Other sizes of tubing come in handy for the various individual parts, although most of these can be made from solid stock. Bar aluminum is recommended for the inside parts, as it is lightweight and easy to turn on the lathe.

4y:>X hunting scope: Fig. 2 shows the

y.',v//////// ^.>/^/y>////w//^/.v.v//^jj^7Z

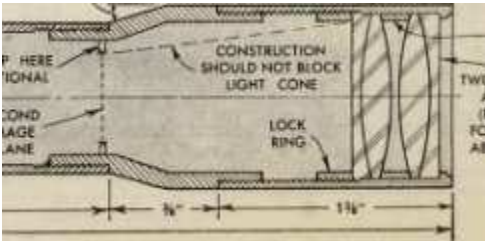
.....W,,,, ^^^ ^^^^ ^^^^ ^^^^

STOP HERE^^^^ "A^

OPTIONAL I

SECOND IMAGE PLANE

OVER-ALL LENGTH, 10 %



^4" SPACER

EYEPiece

TWO 25 X 95 MM.

ACHROMATS

(EQUIVALENT

FOCAL LENGTH

ABOUT 50 MM.)

ERECTORS SECOND EYEPiece

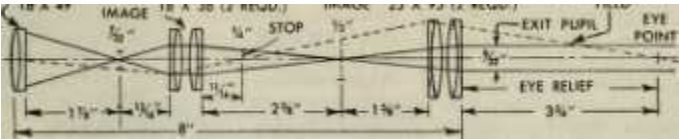
16° APPARENT

18 X 49 .wa'a-c 18 X 36 (2 REQD.) IMAGE 25 X 95 (2 REQD.) FIELD

IMAGE ^^ ' I

^^ ,,, STOP VV .----m-ffV-- fT^EXIT PUPILJ

EYE POINT



H^,,,4%-^ ,,,£

DESIGN No. 2 2 > ^ X

(UNIVERSAL FOCUS)

15 X 41 (2 REQD.)

10 A 00 1



.16*

} • / " * 4 * 11 / 8 1 f c [

JL

-2' / 2" -

SPACING LAYOUTS

— ALL DESIGNS ARE TO SAME SCALE ALL DIMENSIONS ARE GIVEN IN INCHES DIA. OF LENSES AND FOCAL LENGTH ARE SHOWN IN MM.

- FIELD OF VIEW IS EXPRESSED IN FT. AT 100 YDS. DISTANCE
- LIGHT VALUE IS THE DIA. OF THE EXIT PUPIL IN MM., SQUARED

DESIGN No. 3

3 X FIELD - 28 FT.

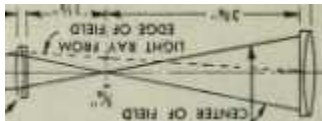
(UNIVERSAL FOCUS BEYOND 10 YDS.)



DESIGN No. 4

25X95 LIGHT RAYS FROM 15X41)

CENTER OF FIELD Y



STOP 18 X 80

(UNIVERSAL FOCUS)

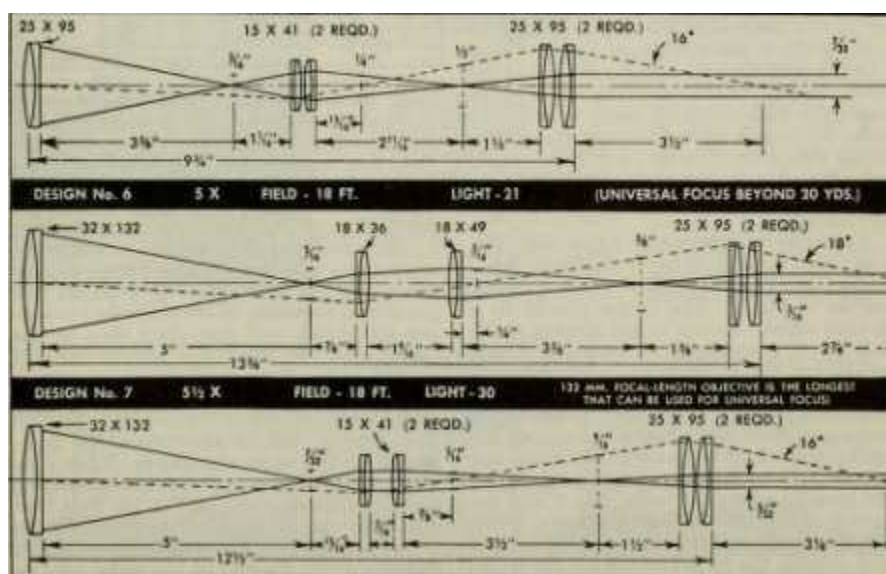
„„ 25 X 95 (2 REQD.) 'H ^ -m n-i ^ 20*



■ ^l'/2"-*i

-13'a"-

FIELD ■ 26 FT. LIGHT-36 (WIDE-SPACED ERECTORS DECREASE EYE RELIEF)



DESIGN No. 8

(UNIVERSAL FOCUS BEYOND 30 YDS.)

optical layout for design No. 1 which is a good 4y2X hunting scope. Like the other diagrams, this one shows how the lenses should be spaced, and also indicates the diameter of the stops. Every scope should have one glare stop between the objective and the first image plane. The diameter of this stop at any location is determined by drawing lines. Fig. 2, from the first image plane to the edge of the objective. The objective stop behind the erector-lens cell screens unwanted light from the second image. Fig. 6 details typical construction of the 4V2X scope in full size, but this can be varied to suit particular requirements. The feature of this type of construction is that the objective and erector lenses are mounted in separate cells and thus are adjustable. The objective can be turned in or out and the erector lenses moved over a considerable distance in the threaded tube liner. With these two adjustments, it is perfectly safe to cut the main tube to net length before testing assemblj'. Take time to lap the inside of the tube with a brass plug, using fine abrasive and oil, Fig. 9, to assure easy fitting of the tube liner and glare stop. The

main tube is short enough to permit threading in a four-jaw chuck, as shown in Fig. 10. Work all threads to full depth and make them somewhat loose for easy hand-turning, as tight threads are a nuisance. A 40 or 48 pitch is recommended for all the threads. The table, Fig. 12, lists double depth of threads which is subtracted from the major, or outside, diameter of the mating part to give the bore, or inside diameter, of the larger tube. Also listed is the amount of infeed needed to cut a full thread with the compound set at the usual 29-deg. angle. Turning the various lens cells and retaining rings is ordinary lathe work and should present no appreciable difficulty. The spring for the reticle cell, Fig. 3, can be made from a $\frac{1}{4}$ -in. metal-cutting jigsaw blade with the teeth ground off.

Assembly of riflescope: After the main tube and various other units have been made, the scope should be given a bench test as in Fig. 8. The target should be a distant object. As one is not always available, it is convenient to make a simple collimator, Fig. 7, which will serve the purpose. Using a lens of 5 or 6-in. focal length, locate a tracing or wax-paper target at the focal-length distance and place a lamp directly in front of the target. The setup can be checked by holding a small mirror in the parallel emergent beam, Fig. 7, and redirecting the light back to the target. When the target is properly spaced, the mirror will refocus the target image on the target itself. If available, reflector sights or similar optical devices can be used as collima-



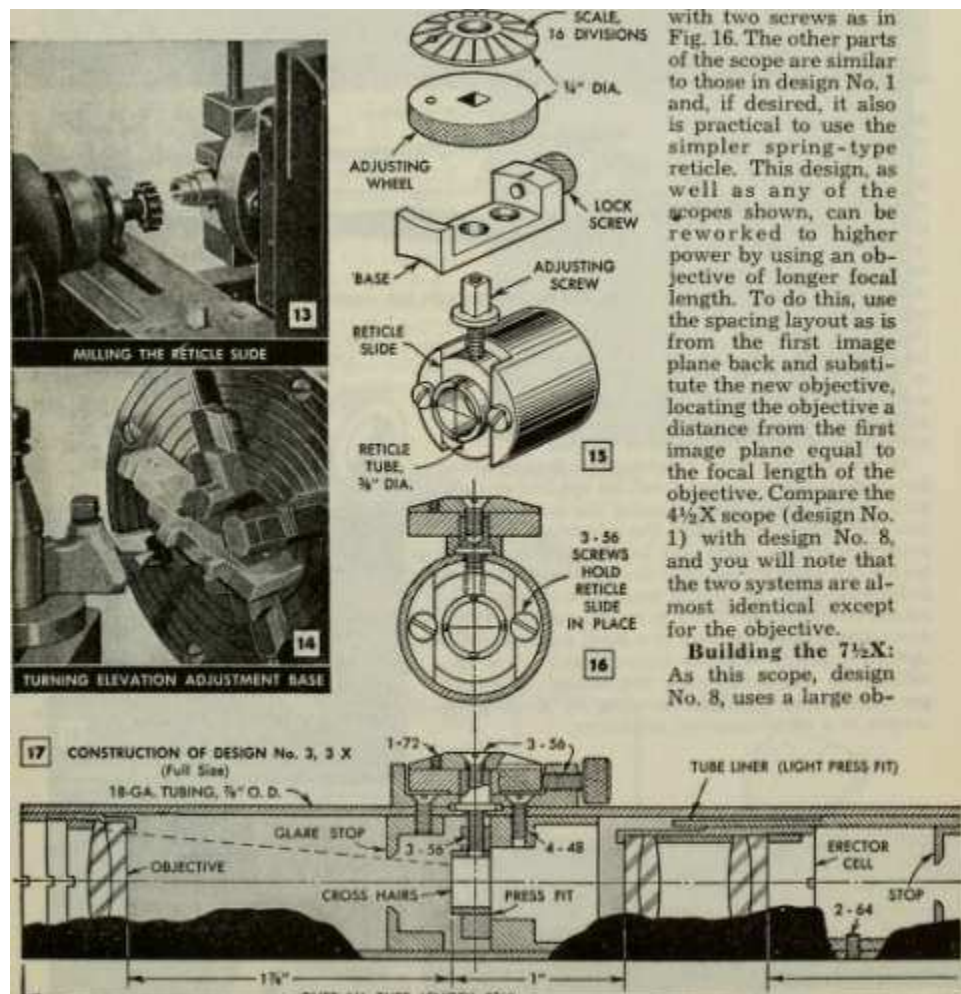
TUBE MOUNTED IN 4-JAW CHUCK FOR THREADING

tors. As pictured in Fig. 8, the test setup is arranged alongside the main tube, placing the objective and eyepiece at the positions they will occupy when mounted. Then the target is brought into sharp focus by moving the erector cell back and forth. After this is done, the reticle cell is fitted in place and moved as needed to bring the cross hairs into sharp focus. When proper spacing of the parts has been attained, begin actual assembly of the scope by mounting the reticle cell and glare stop in the main tube. The tube liner also is inserted at this time. Note that the glare stop is turned so the spring holds the reticle cell against

both adjusting screws. Figs. 4 and 6. The erector cell is approximately positioned in the same operation. When this much of the assembly has been completed, test the scope as shown in Fig. 18. Note that the eyepiece is reversed end-for-end to permit the lenses to be located the same distance from the end of the main tube as they will be when the eyepiece is actually screwed in place. The objective is not

mounted for the test. All that is done at this point is to focus sharply on the cross hairs, turning the erector cell in or out as required. A final check is made with the eyepiece screwed in place, and the objective is mounted and turned in until any distant object or the target of the collimator is in sharp focus. Move your head from side to side when looking through the scope and note if the cross hairs move over the target. If they do, continue adjusting the objective until the cross hairs stand still on the target regardless of your eye position or movement. After perfect focus is obtained, secure the erector cell with a few drops of shellac.

Construction of design No. 3: This scope,



shown in Fig. 17, features a screw-actuated elevation adjustment and, as it does not have a windage adjustment, the scope mount must incorporate this movement. When constructing an elevation adjustment of this type, all work must be done to hairline accuracy in order to make the device practical. Using a 3-56 adjusting screw in connection with a 16-division scale. Fig. 15, a turn equal to one division moves the reticle about .001

in. which, in this particular scope, moves the cross hairs (changes the point of impact) 2 in. on a target at a 100-yd. distance. Operations for milling the reticle slide and turning the elevation-adjustment base are shown in Figs. 13 and 14. The reticle slide is held in the slot of the adjustment base with two screws as in Fig. 16. The other parts of the scope are similar to those in design No. 1 and, if desired, it also is practical to use the simpler spring-type reticle. This design, as well as any of the ^opes shown, can be reworked to higher power by using an objective of longer focal length. To do this, use the spacing layout as is from the first image plane back and substitute the new objective, locating the objective a distance from the first image plane equal to the focal length of the objective. Compare the 4y2X scope (design No. 1) with design No. 8, and you will note that the two systems are almost identical except for the objective.

Building the 7V2X: As this scope, design No. 8, uses a large ob-

TUBE LINER (LIGHT PRESS FIT)

OVER-ALL TUBE LENGTH 8%



jective, it is necessary to make a front extension tube. This is done by internally threading a piece of solid or tube stock and then turning the work onto a threaded stub spindle as in Fig. 21. The free end is then bored and threaded as required to finish the piece, Fig. 22. The

front end and reticle of the IVzX scope are shown in Figs. 19 and 20. This reticle mounting is a simple type positioned by three screws and is intended for zeroing only.

After it is set, the screws are affixed with a few drops of shellac.

Other designs: The construction details given for designs Nos. 1, 3 and 8 can be applied equally well to any other design, using the features you like best. Once it is begun, the construction automatically works itself out because each cell or mounting must thread into the tube and one part determines the size of the next part. For an all-round scope, design No. 1 is recommended. However, every design shown is a good scope and the optical quality, with the lenses specified, is excellent. In damp climates, the lenses should be protected from possible clouding by storing the scopes in a moistureproof container.

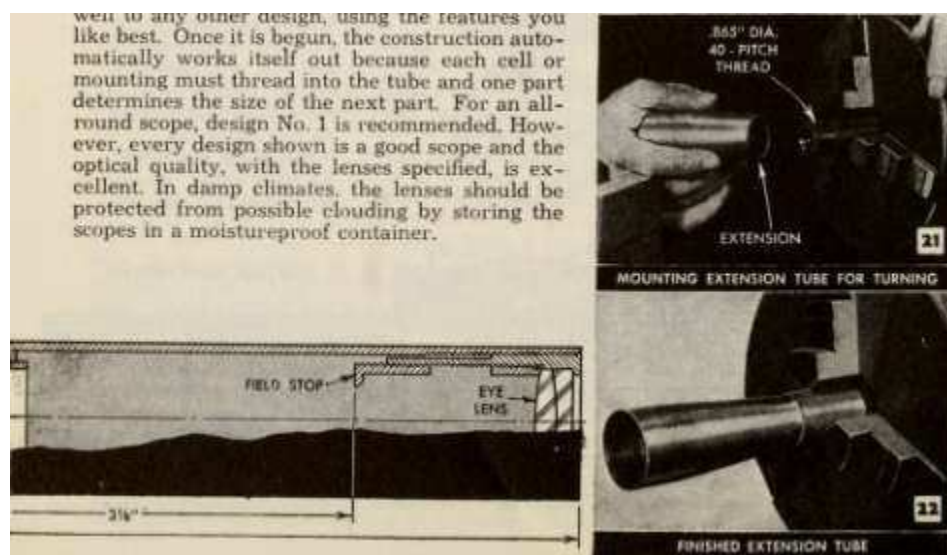
ERECTOR CEIL

(SLIDE FIT

INSIDE MAIN

TUBE)

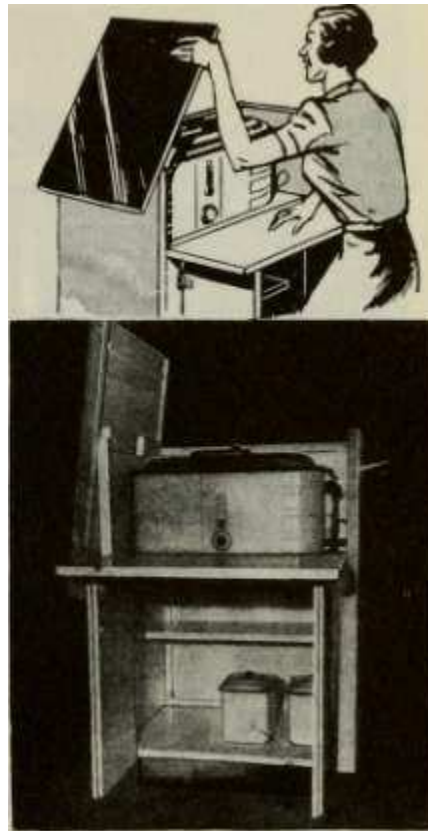
RETAINING RING



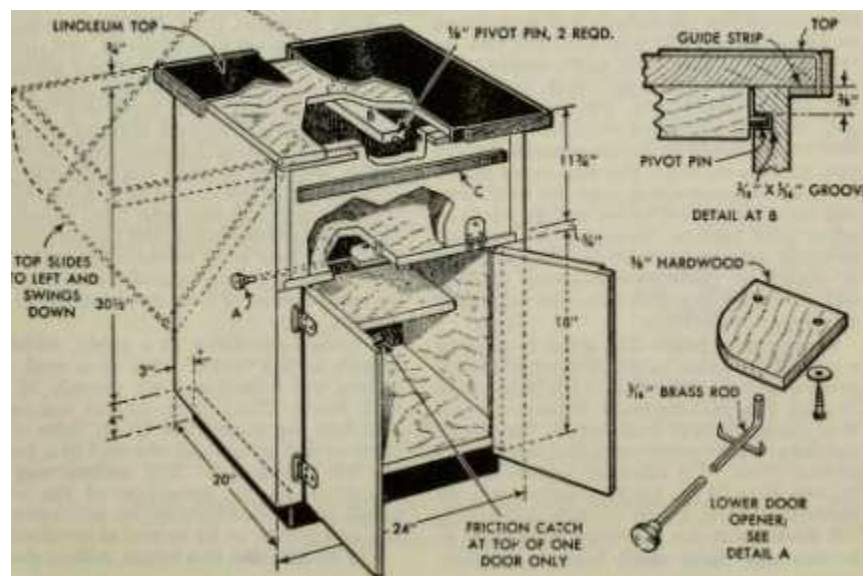
ROASTER CABINET

SEVERAL unusual features adapt this roaster cabinet to use in small kitchens where space is limited. The pivoted top slides sidewise to open and tilts to a vertical position as pictured. This releases the hinged front panel which drops down on the open cabinet doors to form a service shelf. The lower doors are opened by pulling on a single knob which projects from the left side of the cabinet as in the detail A below. This operates the cam mechanism shown in the lower right-hand detail and pictured in position in the center detail. Detail B, upper right, shows how the sliding top is pivoted. The pivot pins slide in grooves cut in the back rail and the inner face of the front panel. Registering grooves also are cut in the front and back facing strips on the edge of the side panel. After the top has been pushed to the left as far as it will go, the pins enter these grooves and

permit the top to swing to the vertical position, as in the photo. With the exception of the base, top and bottom rails at the back and the facing strips, all parts are made from plywood. Strip C serves as a spacer between the front panel and the top edges of the doors when the panel is dropped to the horizontal position: .



$\frac{1}{8}$ " PIVOT PIN, 2 REQD. GUIDE STRIP ^ /



TOP SLIDES
TO LEFT AND
SWINGS

DOWN

LOWER DOOR OPENER;

SEE DETAIL A



FIG. 1 Photo courtesy Insulite Division. Minnesota & Ontario Parser Co.

Matching the roof slope and shingling of the house, the roof of an added room or dormer is completed as soon as possible after erection of the framework, in order to fully protect the opened house against inclement weather

ROOF FRAMING

ANY HOMEOWNER CAN UNDERTAKE the job of erecting a roof over a room or an extension to the outside of a house as shown in Fig. 1. Reshingling an old roof and installing new gutters are even simpler.

Safety precautions: However, don't take any chances on a roof. Provide safe support with good ladders, solid scaffolding or footrests, anchoring these securely before you venture on them. For that extra safety use a strong rope slung over the roof ridge and securely tied at its far end to a tree or other solid anchor. Then tie the free end securely around your waist. On dry wood or shingles, rubber-soled shoes provide added friction, but this becomes negligible on many wet surfaces.

Finding roof pitch: The slope or pitch of a roof of an extra room or dormer should generally conform to that of the house roof. To find this, you measure distances A and B of the house roof as shown in Fig. 2, and use the same proportions to find the pitch of an extra roof. For example, where A is 10 ft., and B is 20 ft., for the house, and the distance B of an added room is to be 14 ft., the distance A for this should equal 7 ft. In this case both roofs have a $\frac{1}{2}$ pitch.

Where A is one-third of B, the roof is $\frac{1}{3}$ pitch, etc.

Roof framing: Roof framing consists of rafters toenailed to wall plates, and usually also nailed to joists. Rafters are joined in pairs at the peak of a roof to a ridge board. The lower ends may terminate at wall plates or extend beyond them as shown in Fig. 3. The extending ends may be of reduced width to prevent the appearance of bulkiness. Rafters should rest on wall plates for a distance not less than 3 in. If notched to extend beyond walls, the notches should not be so deep as to weaken the extending ends. The overhanging ends of rafters may be extra pieces of 2-in. stock nailed to the rafters.

For roof overhang at a gable, which is known as the "rake" edge of a roof, end rafters are sometimes set outside of the wall limits. Then they do not support a roof but are supported by it, their chief purpose being to finish the end of a building for appearance. End rafters may be supported by an extension of the ridge board and cross blocking, by extensions of the wall plates, or by means of brackets.

For an addition to a house, rafters should

be the same kind of wood, the same thickness and width as others of corresponding length elsewhere in the house. On roofs to be covered with asphalt shingles, rafters of 2 by 4, or 2 by 6-in. size are usually adequate for spans up to 8 and 12 ft. respectively, where the rafters are spaced 16 in. on centers. Where longer spans are involved, or heavier roof coverings are used, the rafters must be wider.

As weight of an inclined roof exerts an outward thrust against walls, the rafters should be nailed to joists with 16-d. nails as shown in Fig. 3. Generally it is best to space rafters the same distance as joists so that they can be nailed together at the plates to check outward thrust against the walls. The thrust of rafters against walls is further minimized by using struts, collar beams or both. These also take part of the roof weight and prevent it from sagging.

Collar beams: Fastened to pairs of rafters as shown in Fig. 4, collar beams act both as ties to keep rafters from exerting a thrust against walls, and also as struts to take roof weight and provide resistance against wind pressure. Usually collar beams are nailed to the sides of pairs of rafters as shown in detail A near the midpoint of their span, where such support is most effective. Detail B shows how collar beams are installed for maximum support against the weight of the roof and wind pressure. Here they are toenailed to stringers that fit in notches cut in the rafters and nailed to them. The collar beams then act more like struts than ties. In average home construction, a 2 by 4-in. collar beam installed at every other or every third pair of rafters is usually sufficient. If placed at every rafter, however, and not less than 12 ft. above the joists, collar beams can be used as ceiling joists for attic rooms.

Assembling roof framework: After the pitch of a roof is known it is a relatively simple matter to precut the ends of rafters to the correct angles. A ridge board of 1-in. stock fits

between the upper ends of rafters as shown in Fig. 4-A. Its main purpose is to hold the rafters in position when assembling the roof framework. This is started

2" X 4" RAFTERS

2" X 6" STRUTS

■T

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/ A

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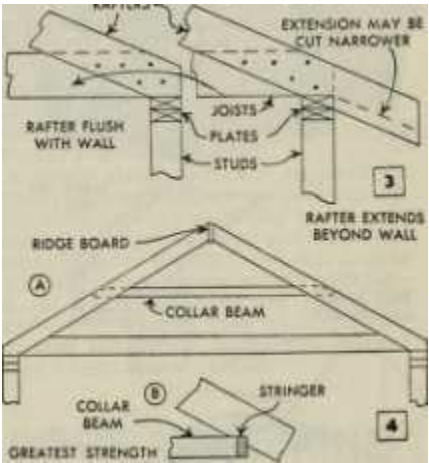
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HOUSE EXTENSION

MATCHING ROOF PITCH

B

EXTENSION MAY BE CUT NARROWER



COLLAR ^-^ BEAM

GREATEST STRENGTH i AGAINST SAGGING

RIOGE BOARD

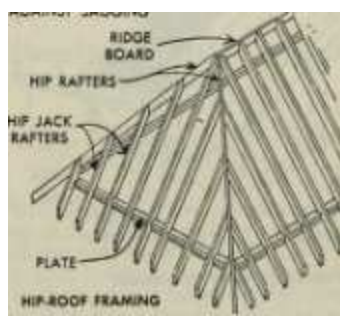
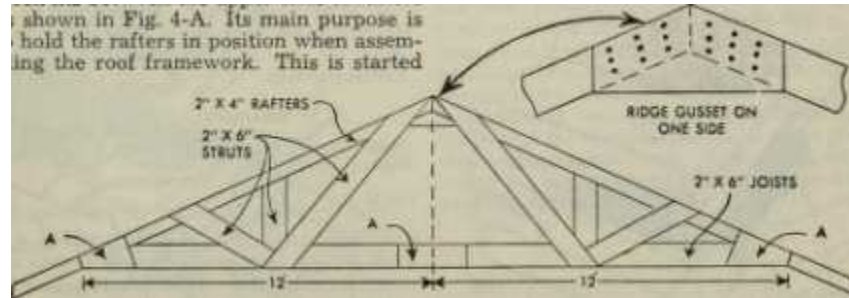


PLATE HIP-ROOF FRAMING

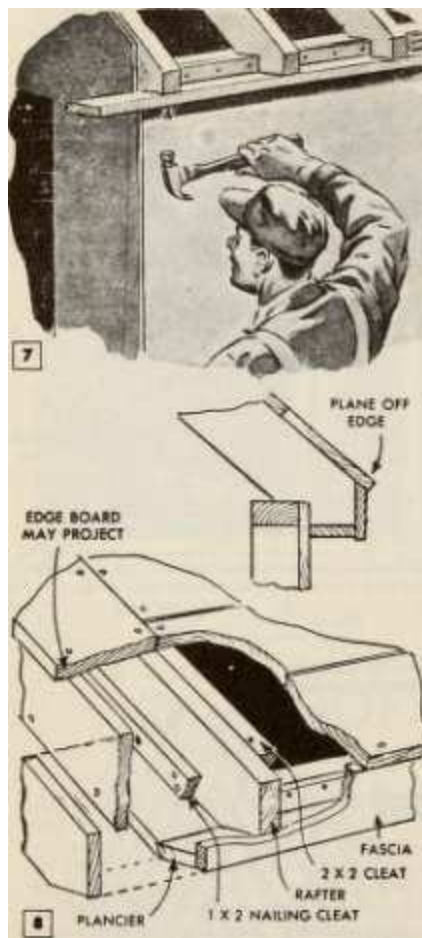
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= H", 5-PLY EXTERIOR PLYWOOD GUSSETS ON BOTH SIDES. DIAGONAL STRUTS ON ONE SIDE, VERTICAL STRUTS ON OTHER

TRUSS ROOF AND CEILING FRAMEWORK

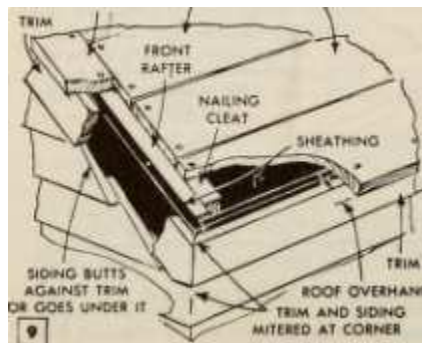
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FASCIA 2X2 CLEAT RAFTER 1 X 2 NAILING CLEAT

PLANCIER CORNER DETAIL OF BOX-TYPE CORNICE

EDGE BOARD / ROOF BOARDS



by setting up a pair of rafters at one end and nailing them to the ridge board, this being suitably braced so that it is level and in the correct position.

On a hip roof, Fig. 5, the corner or hip rafters, and also the hip jack rafters, require compound-angle cuts to fit the ridge board, or to fit each other if the roof comes to a point. Hip rafters usually must be wider than regular rafters because of the added weight they carry. For spans up to 12 ft., hip rafters should be 2 in. wider and

1 in. thicker than regular rafters. For larger spans, the width should be doubled.

A truss roof, in which sets of rafters and joists are combined, is strengthened with struts and plywood gussets as in Fig. 6. Trusses are preassembled with the aid of a jig that assures getting them identical in shape and size. They are toenailed to wall plates and the ridge ends are held in position by a board nailed across them temporarily. Truss framing is ideal for low-pitched roofs, as those of ranch-type houses, where attic space is not used. It is much stronger and just as economical as ordinary roof framing. The joists are held firmly and can have much longer spans than ordinarily. As shown in Fig. 6, a 24-ft. span is possible with the use of 2 by 4-in. rafters and

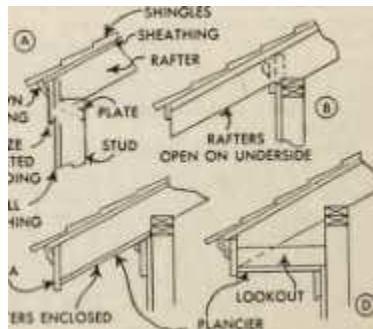
2 by 6-in. joists.

Cornice construction: Cornices are built at the joints between walls and roof. The overhang of a roof determines the exact type and size of cornice, which may vary in

CROWN MOLDING

FRIEZE y RABBETED FOR SIDING

WALL SHEATHING



FASCIA

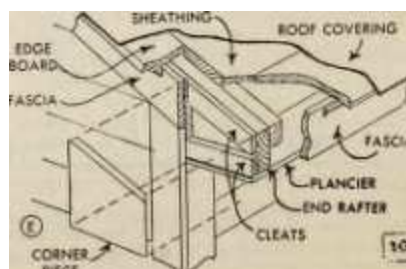
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RAFTERS ENCLOSED

ROOF COVERING

ROOF OVERHANG TRIM AND SIDING MITERED AT CORNER

CORNER DETAIL OF PLAIN CORNICE



style. It may be the box type, Figs. 7 and 8, or a plain one consisting simply of a "frieze" and crown molding as shown in Fig. 10-A. The frieze may be rabbeted to take the narrow edge of siding. Where eave overhang is wide, the extending rafters sometimes are left uncovered on the underside, detail B, or may be enclosed, detail C. In wide box cornices, detail D, the "plancier," which encloses the cornice from below, is nailed to 2 by 4-in. "lookouts." Where overhang of a roof at its gable or "rake" edge is less than that at the eaves, the corner joint may be constructed as shown in detail E.

Roof sheathing: This may consist of 1-in. boards or exterior-type plywood from $\frac{5}{8}$ to $\frac{3}{4}$ in. thick. Roofing boards usually are run at right angles to rafters. Roof sheathing may project an inch or so beyond the cornice trim or it may come flush with it. End grain of sheathing at rake edges of a roof can be concealed by an edge board as shown in Figs. 8 and 9, or by the fascia of a cornice. Where an edge board is used, the roof boards are nailed to a cleat on the end rafter, and the edge board is nailed to the rafter. A piece of siding may be nailed over both, its wide edge along the outside to raise the

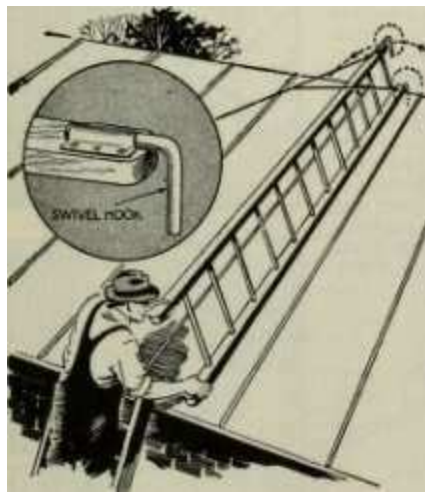
ROOF LADDER

shingles at a slight angle. This prevents roof water from running over the cornice.

However, where wood shingles are to be used, then 1 by 4 in. roofing boards can be spaced center to center the same distance as the weather exposure of the shingles. This loose type of roof sheathing, without the use of felt under the shingles, costs less than tight sheathing. It is recommended for warm, humid climates as it permits ventilation and helps to prevent shingle decay. Where insulation is used on a ceiling just below the roof, such circulation minimizes condensation on the underside. However, in colder climates where a warm roof is needed, a tight sheathing with building paper over it is recommended.

A tightly sheathed roof is required for mineral-coated asphalt or asbestos-cement shingles. Some sheathing has tongue-and-groove edges at sides and ends and does not require nailing the ends of boards to rafters, but only where boards cross rafters, for which 8-d. nails are used. The sheathing is covered with 15-lb. asphalt-saturated felt before laying the shingles where a tight roof is desired.

ROOF MEASURING



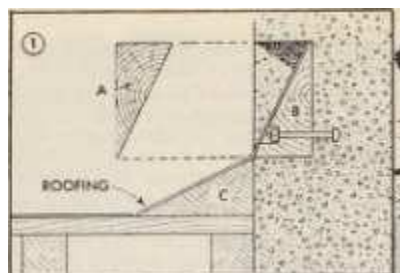
To increase the ease and safety of moving a ladder along a roof, one workman used swivel hooks. These rest flat on the roof as the ladder is slid into place, automatically dropping over the ridge. In moving the ladder along a roof, it is easy to roll it over and over, one hook engaging the roof at all times so there is no danger of it slipping or falling.

Simple Method of Measuring

a Pitched Roof

to Determine the Area

With a ball of twine, you can measure the area of a pitched roof from the ground. Pull the twine end from the center of the ball and, holding the end, throw the ball over the roof to a helper on the other side, who then ties a marker, such as a nut, to the line. Now, pull your end to raise the marker to the eave and, holding the line taut, knot it where it meets the base of the building at each side. Remove the twine, measure the distance between the knots and subtract twice the distance from the marker to the closest knot which gives you the width of the roof. Multiplying this width by the length of the roof gives the area if both sides are alike.



ROOFING

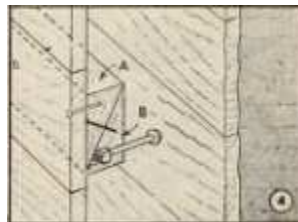
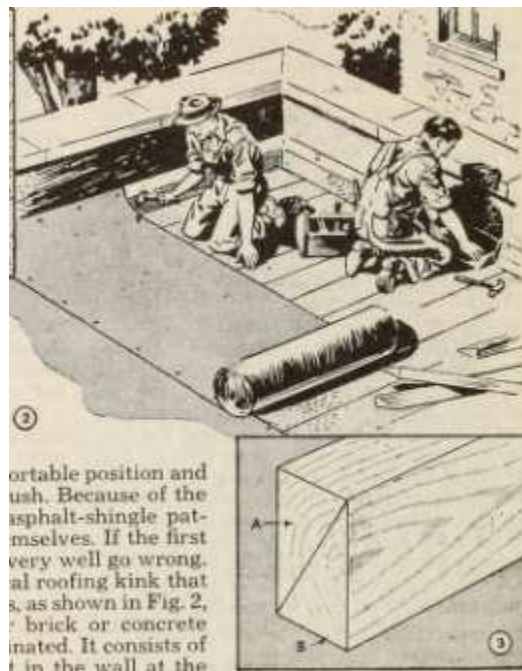
Roofing is the simplest of all the major repair jobs that the homeowner can tackle himself without professional help. It's easier to do than painting, except that you have to climb a little

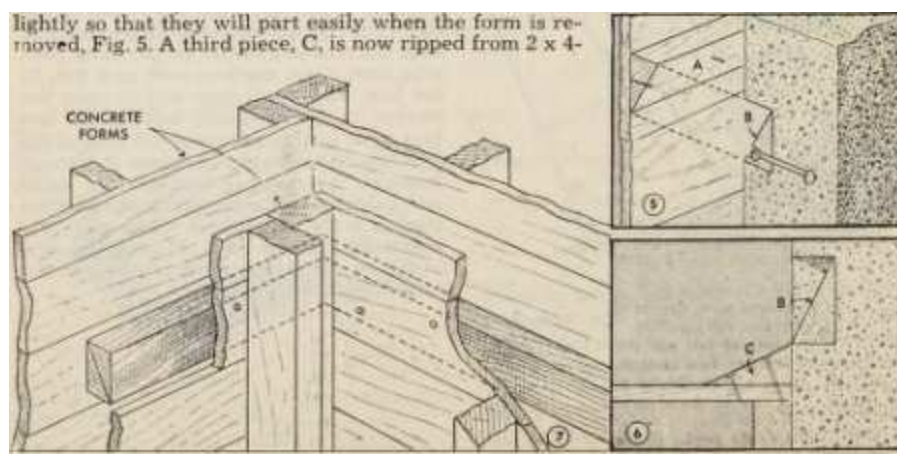
higher, work in a somewhat less comfortable position and swing a hammer instead of a

paintbrush. Because of the mechanical features of the various asphalt-shingle patterns, the shingles practically lay themselves. If the first course is started correctly, you can't very well go wrong.

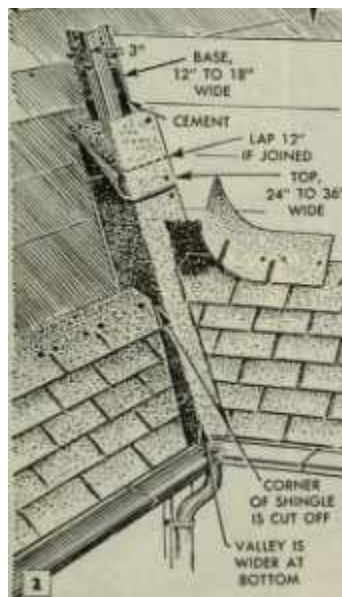
Flat-roof garages: Here is a practical roofing kink that is especially suited to flat-roof garages, as shown in Fig. 2, and similar structures having either brick or concrete walls. The metal roof flashing is eliminated. It consists of a wood-lined undercut or recess cast in the wall at the time of pouring or formed in the brickwork by means of a wooden pattern, the parts of which later are used as a nailing base for the roof covering. After the concrete forms are up, 2 x 4-in. stock is ripped diagonally lengthwise as in Fig. 3, forming the pieces A and B as shown. The latter piece is fitted with 6-in. bolts, spaced 2 ft. apart and set flush. Then the piece A is nailed to it as shown in Fig. 4. The top edge of the piece A should be coated with grease so it will not stick to the concrete or mortar. After this, the whole thing is nailed or screwed to the inside of the form, Fig. 7, screws being better for this purpose as the piece A is easily removed later and saved. The two pieces should be merely tacked together lightly so that they will part easily when the form is removed. Fig. 5. A third piece, C, is now ripped from 2x4-

CONCRETE FORMS





No 15 FELT (FOR NEW CONSTRUCTION) ^



VALLEY IS WIDER AT BOTTOM

Valleys are covered with double thickness of mineral-surface roll roofing. Thicker end tougher types of felt ore often used for the damp course. Few nails should be used. The strips of felt should be given a generous overlap to shoot-off the rain. The felt is best held
















down with full-length battens laid at right angles to the length

in. stock as already described and nailed to the roof boards in the position shown in Fig. 6. Finally, roofing is laid as in Fig. 1, part A being renailed to part B as the finishing operation which brings the recess flush with the wall. A coating of roofing tar worked into the joint finishes the job.

LAYING ASPHALT SHINGLES

There are two main types of roof, flat and pitched. The surface of the flat roof will have only a slight inclination, or a sufficient amount of fall to allow the rainwater to flow into the outlets, whereas the surfaces of pitched roofs will vary in inclination from an almost flat roof to one of extreme pitch. The angle of pitch is governed by the type of covering material, but the architectural design of a building may be the deciding factor. When a roof is Vz pitch, that is, when the rise is equal to half the span, the covering material recommended is asphalt shingles. Type and position of building are important factors in selecting a suitable arrangement.

Selecting the shingle pattern: Data on several of the more popular shingle patterns, or types, is given at the top of the opposite page. The individual shingle is pretty much the same product in any type or style. It averages about the same weight per unit and has essentially the same proportions in the mineral covering. The difference in the style of modern roofing and the cost of the job depends on whether the shingles are laid single thickness, double thickness or triple thickness. Probably the most popular choice is the double thickness, or double coverage roof, and in this class the three-tab square butt and the three-tab hex strip shingles are leaders, especially on new work. Single-coverage shingles, such as Dutch lap, and interlocking

| <i>Asphalt shingles</i> | WEIGHT PER SQUARE | UNIT SIZE | NAILS PER SQUARE | COVERAGE | | |
|--|-------------------------|---------------|-----------------------------------|-------------------------------|--|---|
| | | | | PER BUNDLE | X-RAY VIEW | PERCENT |
|  3-TAB SQUARE | 210 LBS. | 12" X 36" | 1.9 LB., 1" OR 3.2 LB., 1 1/4" | 33 SQ. FT. (1/3 SQUARE) |  | 1 PLY—21% 2 PLY—59% 3 PLY—39% 100% |
|  2-TAB HEX | 167 LBS. | 11 1/2" X 36" | 1.3 LB., 1" OR 2.3 LB., 1 1/4" | 50 SQ. FT. (1/2 SQUARE) |  | 1 PLY—22% 2 PLY—63% 3 PLY—15% 100% |
|  3-TAB HEX | 167 LBS. | 11 1/2" X 36" | 1.3 LB., 1" OR 2.3 LB., 1 1/4" | 50 SQ. FT. (1/2 SQUARE) |  | 1 PLY—22% 2 PLY—63% 3 PLY—15% 100% |
|  CLIP DUTCH LAP | 162 LBS. | 12" X 16" | 0.9 LB., 1" OR 1.5 LB., 1 1/4" | 50 SQ. FT. (1/2 SQUARE) |  | 1 PLY—61% 2 PLY—29% 3 PLY—10% 100% |
|  THATCH | 172 LBS. | 10" X 36" | 1.2 LB., 1" OR 2 LB., 1 1/4" | 50 SQ. FT. (1/2 SQUARE) |  | 1 PLY—14% 2 PLY—72% 3 PLY—14% 100% |
|  INTERLOCK | 138 LBS. | 16" X 16" | 0.6 LB., 1" OR 1.1 LB., 1 1/4" | 50 SQ. FT. (1/2 SQUARE) |  | 1 PLY—60% 2 PLY—31% 3 PLY—9% 100% |
|    | | | | | | |

NAILS SHOULD BE 1" LONG FOR NEW WORK, 1 3/4" FOR REROOFING
GOOD BASE IS ESSENTIAL. SPLIT AND NAIL DOWN WARPED SHINGLES
STARTER COURSE CAN BE INVERTED SHINGLES OR ROLL ROOFING



ROOF CEMENT IS VERY ESSENTIAL FOR TIGHT FLASHINGS AND VALLEYS
RIDGES CAN BE FINISHED WITH CUT SHINGLES OR ROLL ROOFING

This page pictures and details nearly everything you need to know about a common roofing job. it's important to note the length of the nails recommended for new and old work. Fig. 3, and in over-roofing it's equally important to avoid driving the nails too far down, as expansion and contraction of shingles may cause breaks

Treatment of roof edges: The terms "eaves" and "rake" are used by builders to refer to the edges of the roof, eaves meaning the lower edges and rake indicating the run from the eaves to the ridge. If the old roof is in good condition to start with, it is unlikely that the edges will need any special treatment, but if the shingles are in poor shape then some preparatory work may be necessary. Figs. 3 to 8 inclusive picture roofing steps common to all jobs and Figs. 13 to 24 inclusive picture the step-by-step procedure, including the regular valley treatment. Figs. 2, 18, 19, 20 and 21. As a rule, the first step is to prepare the roof edges. Rake boards or metal drip edges are installed, the boards being installed in the same positions as indicated for the drip edges in Figs. 8 and 9. When overroofing a wood-shingle roof it is the visual practice to use rake boards of beveled siding, 4 to 6 in. wide, to form a drip edge along the rake. It also is good practice to cut away the shingles along the rake so that the board bears directly on the roof

boards with the thicker edge out. This has the effect of tilting the shingles slightly away from the edge, forming a watershed which prevents water from running down the edge of the roof and dripping from the fascia board. Some builders may even use 12-in. strips of roll roofing as in Fig. 10. It is a common practice to set the drip edges in roofing cement to prevent seepage of water under the shingles. On new roofs, Fig. 25, felt undercovering goes on first, then the drip edges and finally the shingles. Preparing valleys: Figs. 18 to 21 inclusive show how the valley is prepared on old work. First a narrow strip of roll roofing is cut and laid in the space between the shingle ends to build up level. Then the full-width valley strip of roll roofing goes in. Fig. 18. Next, chalk lines are snapped to indicate the taper of the valley width, Fig. 19. Finally, lay a line of lap cement outside the chalk lines from top to bottom on both sides of the valley as in Fig. 20. Don't be confused by the forked arrow in Fig. 21. During heavy rainstorms when even a steep valley runs full from a point well up near the ridge, some water may take the direction of the small arrow, which makes it necessary to take the precaution of cutting the corner of each shingle and bedding the exposed edge in roofing cement or lap cement. Full-length valleys, such as those formed where the ridges meet at right angles at the same level, should be 6 in. wide at the top and should widen at the rate of about $\frac{1}{4}$ in. to the foot down to the eaves. Note that the chalk lines. Figs. 19 and 20,

'iYene'^ a Putcene Stmcf S^cwui^

, ^fr^r,.,^ Q f / qTANDARD THIfK Bll



Lay a row of inverted shingles at eaves to form the starter course

First course starts with full shingle with the edge flush at eaves

Begin second course with full shingle less 6 in. Cut shingle from back



Four nails fasten each shingle. Shingles are cut and flashed to Two layers of roll roofing used Nail straight to avoid cutting all parts projecting above roof in valley, same color as shingles



Chalk lines are snapped on valley Shingle ends at valley are bedded Top edge of each shingle at valley to indicate trim line for shingles in roofing cement to turn water is cut off diagonally as shown



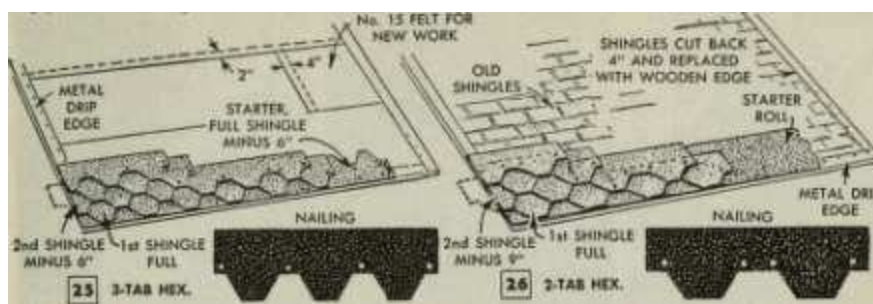
Plastic roof cement assures tight joints at vent pipes and chimney

On overroofing jobs shingles often are fitted under old flashing

Ridges and hips can be finished with 12-in. strips of roll roofing

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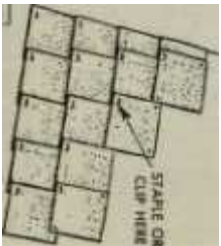


NAIL TWO CORNERS ONLY

widen in about this relative proportion. Laying shingles: With the drip edges and valleys completed, the rest is plain sailing on an ordinary roofing job. Caution: On a steep roof, Fig. 1, don't take chances! See that all ladders reaching to the eaves stand solidly and make sure that scaffolding and footboards are anchored securely before trusting your weight on them. Some roofers, working on high, steep roofs, take the added precaution of tying a light rope loosely about the waist or under the arms. The free end of the rope is thrown over the ridge and tied securely to a tree or some other solid anchorage on the opposite side of the building. Then, if you slip, or something lets go, the rope will save you from a possible serious injury. The starter course, pictured in Fig. 5, is a row of inverted

shingles. Figs. 13 and 25, or a roll of roofing 12 to 18 in. wide as in Figs. 5, 10, 26 and 27. In ordinary roofing practice, the shingles overhang V^{\wedge} to $\%$ in. at the rake edge and $\%$ in. at the eaves when applied over old shingles. These overhangs can be slightly less over metal drip edges. Nearly aU shingle units are self-spacing, that is, one butts against the other, and the head-lap and alignment are more or less automatically taken care of by cutouts, slits or other mechanical features of the individual shingle units. However, it's a good idea to snap a chalk line occasionally as the work progresses to check the horizontal alignment. An example of how the head-lap and alignment are governed by the cutouts and aligning slits provided on each

BUTT HERE



[ao] START WITH 3" STRIP [si] ALLOW 2" HEAD LAP [H] SIDE UP SHINGLES 3"- [ss] STAPLE THE FREE CORNER

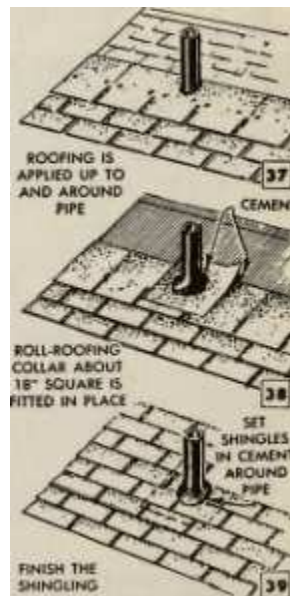
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unit is the three-tab hex shingle. The usual exposure, or lay, is 5 in. to the weather. This means that after the first course the succeeding courses are set flush with the cutouts. Also, it is common to break the cutouts every second course, as in Fig. 25. This is done by alternating a full shingle unit and another with 6 in. cut off the outer end. This forms the starting shingle on the succeeding course. An alternate method is detailed in Fig. 26. Matching the cutouts on square butt shingles can be done by several methods as detailed

in Figs. 9 to 12 inclusive. Other methods of laying different types are detailed and pictured in Figs. 27 to 33 inclusive.

Flashing to side walls, vent pipes and chimneys: Figs. 34 to 43 inclusive detail and picture the procedures in flashing the roof to various parts of the house structure to prevent leakage. Three methods of joining to side walls are pictured in Figs. 34, 35 and 36. How to flash to a vent pipe projecting through the roof is detailed clearly in Figs. 37, 38 and 39. Both metal flashings and self-flashings are used, the latter being made either from the shingles or from roll roofing. On chimneys that project from a steep roof at some point below the ridge, it is customary to fit a watershed, or cricket, on the upper side of the chimney as in Fig. 40. The cricket can be made of wood as suggested, but for maximum durability it should be made of galvanized sheet metal or copper. All flashings, except metal, should be coated liberally at the joints with roofing cement carefully knifed into all openings and well smoothed on the exposed surfaces.



FINISH THE SHINGLING

"PC^ ^ICU^CK^



Here's the way to flash a chimney on an overroofing job. On steep roofs a wooden or metal cricket usually is fitted above the chimney as in Fig. 40. New shingles are then brought up to the chimney and roll-roofing strips are nailed and cemented in place as in Fig. 41. Job is then completed with shingles and cap flashing



LAYING ROLL ROOFING

As described previously, laying composition shingles is one of the easiest home repair jobs, but laying roll roofing is even simpler as it comes in continuous rolls of a uniform width and length. You simply unroll the covering, cut it to the lengths required and nail it down. It's less expensive than shingles and where appearance is not of the first importance, it has a wider application.

For barns, garages, etc., the smooth-surfaced roofing roll is recommended for its low cost and durability. The smooth-surfaced roll comes in various weights making it suitable for most roofing jobs.

Most popular of all is the mineral-surfaced roll roofing that can be applied to a variety of requirements and can be laid with exposed or concealed-nailing method.

Mineral-surfaced roll roofing: This probably is the most popular type as it can be applied either vertically or horizontally and with exposed or concealed nails, Figs. 48 and 58. The edges of the roofing should overhang slightly at the eaves and along the rise. Fig. 49. Another method is to turn down the edge and nail it. Figs. 44 and 50. Old shingled roofs are prepared for reroofing by nailing down loose shingles. Fig. 46, and applying drip boards. After the first roll, or sheet, is applied at the eaves, the second sheet is located by means of a chalk mark 2 in. down from the upper edge of the first sheet. Fig. 51. While a 2-in. lap is regular practice on the average roof, low-pitched

-ALL SHINGLES

NAILED ROLL ROOFING ^CEMENTED 1 3" LAP ^CEMENTED 4" LAP

MINIMUM PITCH FOR THE VARIOUS TYPES OF ROOFING



To prepare old shingled roofs, nail down loose shingles and apply drip boards at eaves and gable ends. If the slope of the roof is a distinct inclination to the horizontal, care must be taken to insure that the angular pitch is sufficient for the type of roof covering to prevent water from seeping up between the lapped joints. Roof may have to be reinforced to prevent sagging of the roof under the additional weight

Weight Per Square

Noils Per Square

Coverage Per Roll

Remarks

pi?;; SATURATED'i-';;;j-^;^

15 LBS. 30 LBS.

36" XI44' 36"X72'

Vj LB.,1" 6" SPACING

400 SQ. FT 200 SQ. FT.

15 LB. WEIGHT IS CALLED No. 15. 30 LB. IS No. 30. No. 15 IS COMMONLY USED FOR UNDERLAY ON NEW WORK



45 LBS. 55 LBS. 65 LBS.



VU LB.,1"

OR

1 % LB., 1 %"

(2" SPACING)

100 SQ. FT. (1 SQUARE)

INEXPENSIVE ROOFING FOR BARNs, GARAGES, ETC. WEIGHTS ARE SOMETIMES CALLED MEDIUM, HEAVY AND EXTRA-HEAVY

100 SQ.FT. (1 SQUARE)

MOST POPULAR ROLL ROOFING FOR ALL PURPOSES. CAN BE APPLIED WITH EXPOSED OR CONCEALED-NAILING METHOD



36"X42' 32"X48'

1% LB.,1"

OR

2'^ LB.,1%"

100 SQ.FT. (1 SQUARE)

AN ATTRACTIVE YET INEXPENSIVE ROOFING. CAN BE APPLIED WITH EXPOSED OR BLIND NAILING CLIPS



140 LBS.

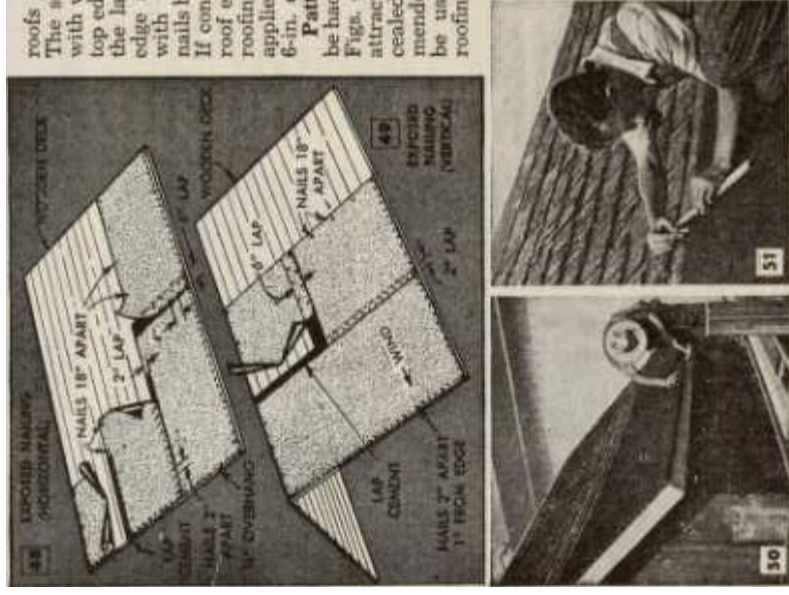
36"X36'

1 LB.,1" OR

1' / 4 LB., 1 %'

50 SQ. FT. (1/2 SQUARE)

THE BEST ROOFING FOR LOW PITCHES. CAN BE USED ON ROOFS HAVING AS LITTLE AS 1" RISE PER FT. (CEMENT REQ'D)



roofs require wider laps, Fig. 45. The second sheet is held in place with widely spaced nails along the top edge while cement is spread on the lapped area. Then the lower edge is pressed into firm contact with the cement and nailed, the nails being spaced about 2 in. apart. If concealed nailing is desired, the roof edges are fitted with strips of roofing, Fig. 55, and the roofing is applied with a 3-in. head lap and 6-in. end lap, all cemented.

Pattern-edge roofing: This can be had in a variety of edge patterns. Figs. 47, 54 and 56, and makes an attractive, inexpensive roof. Concealed nailing. Fig. 55, is recommended although exposed nails can be used if desired. Pattern-edge roofing must be unrolled to break



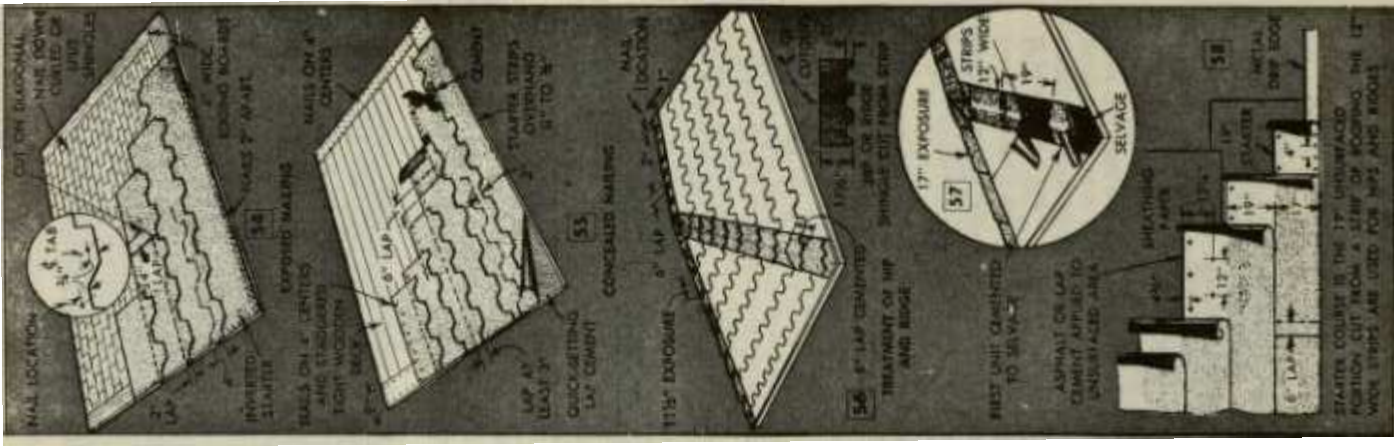
Edges of the roll roofing can be folded over and nailed as in Fig. 50. Measure and snap a chalk line to show the amount of lap as in fig. 51. Finish the ridge as in Fig. 52, using a 10 or 12-in. strip of roll roofing



the tabs which hold the strips together. Allow them to flatten for several hours before laying. The strips are then loosely rerolled for application as in Fig. 53. Valleys, Fig. 59, are treated in the same manner as for a shingle roof. Ridges can be covered with a single strip of roll roofing 9 to 12 in. wide. Fig. 52, or with individual short strips as in Figs. 56 and 57.

Wide-selvage roll roofing: If you are covering a roof that is nearly flat, 19-in. selvage roofing makes a tight double-coverage job with laps cemented the full 19-in. width. Fig. 58. The 19-in. lap is smooth surfaced for easy application of the cement. Only the exposed surface is mineral coated. Note that the starter course is a strip of the unsurfaced portion. This type of roofing usually is laid over sheathing paper for longer wear and better insulation.





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PORTICMM CUT fROM A STRIP Of JJOOHNG. THE 12" j WIDE STRIPS ARE USED FOR MIPS AND fIIDGES

ROOFING REPAIR

Roof Cement Secures Shingles Against Strong Winds

Composition shingles can be protected against windstorm damage most easily, I have found, by applying a small amount of asphalt roof cement under each shingle to secure it to the one below. A putty knife is used to raise each shingle and then for applying the cement about an inch back from the edge. Although requiring more time to apply than the canned liquid tar usually sold with roll roofing, the cement remains tacky over a longer

period, adapting itself readily to any over-all movement of the shingles such as that due to strong winds or to a heavy snow load.

Sheet-Metal Hanger Permits Individual Replacement of Broken Roof Tiles

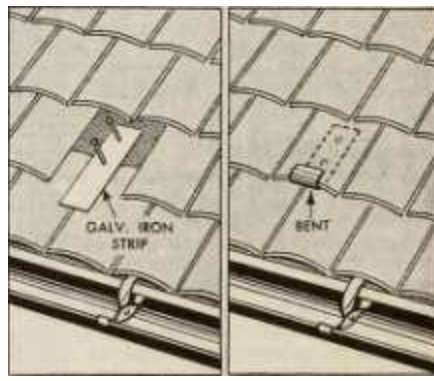


It's «ot necessary to remove half the tiles from a roof to replace one or two broken ones if you use this easy method of attaching the new tile with a sheet-metal hanger. The first step is to remove the broken tile by sawing or cutting through the nail which holds it in place. Fitting a hacksaw blade with an improvised handle, by bolting and taping a piece of flat iron to it, provides a handy saw. The blade can be worked back and forth under the tile. A secon^c method is to cut a notch near the end of an old hacksaw blade to form a hook. The edges of the notch are sharpened and the other end of the blade is wrapped with tape. With the notch hooked over the nail, a sharp downward pull of the blade will cut the nail in two, permitting removal of the tile. To install a new tile, nail a galvanized-iron strip to the roof, as in the left-hand detail. Then, slip the tile into position and

Linoleum "Flagstones" on Roof Protect the Covering

If you have a flat roof that is walked on occasionally, 2-ft. squares of old linoleum applied to the roof about 6 in. apart will protect the covering. The linoleum can be applied with asphalt asbestos roofing cement, and the top surface of the squares can be painted to preserve the finish. You will find that linoleum squares ai-e better for this purpose than boards, as water will run off in any direction without collecting in pockets and eventually causing the covering to decay.

bend the end of the metal up and around the lower edge of the tile to clamp it tightly in place.



Repairing Leaky Metal Roof

If a corrugated metal roof leaks at the joints, sometimes it can be repaired by applying strips of asphalt roofing paper to the joints between the metal sheets as indicated. Make the strips about 2 in. wide. This repair is especially helpful if high winds have a tendency to drive rain between the sheets at the joint.



ROUTING WITH

A

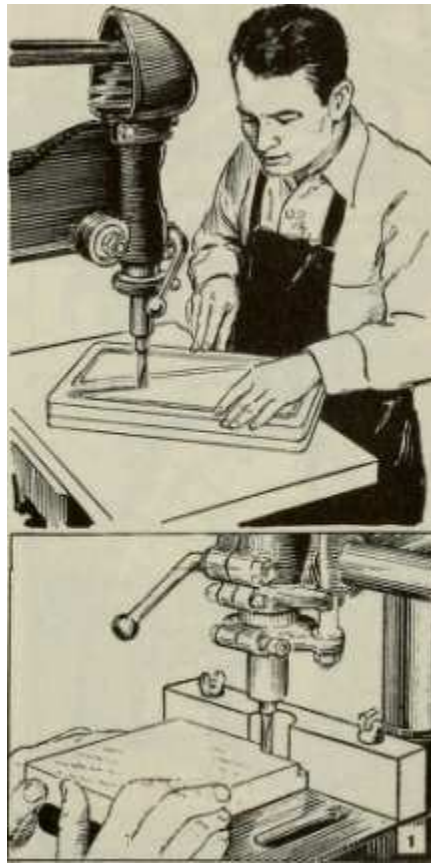
DRILL PRESS

Easy-to-make jigs that clamp to the drill-press table guide the work for accurate uniform routing

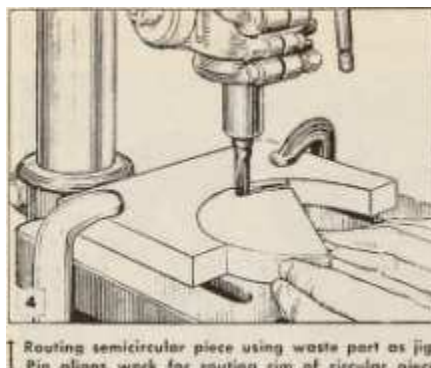
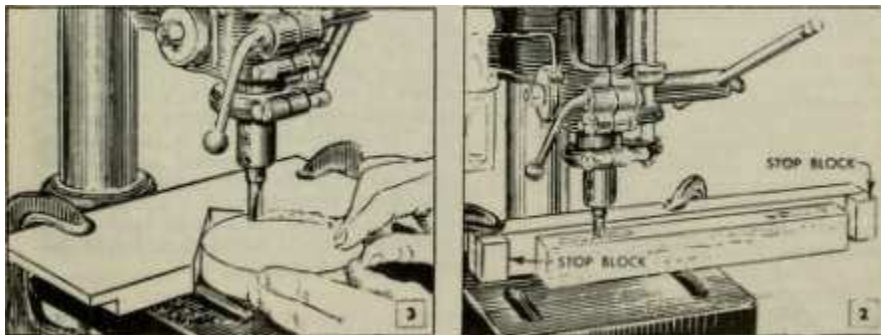
A FEW SIMPLE JIGS plus an assortment of router bits are all that is needed to convert a drill press into a router. A spindle speed of about 5000 r.p.m. is satisfactory for most routing. However, when using small-diameter router bits or when production-routing, 8000 to 10,000 r.p.m. is recommended. In most cases, the jig or guide fence, shown in color on the illustrations, should be clamped to the drill-press table back of the work. The work is fed from left to right, or against the cutting rotation of the router bit. If it is necessary to clamp the fence in front of the work, the work must be fed from right to left. To avoid heating the router bit and thus drawing the temper, the work is fed slowly and uniformly.

Rabbeting is done by guiding the work against a straight fence having a semicircular cutout for the router bit, as in Fig. 1. The size of the rabbet is controlled by locking the spindle sleeve at the desired depth of cut and adjusting the fence forward or away from the router bit as required. Fig.

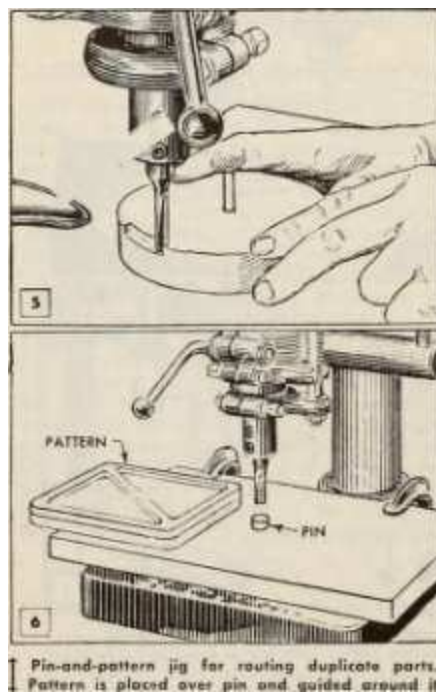
Varying distance of V-block jig from router permits accurate routing of wide range of circle sizes



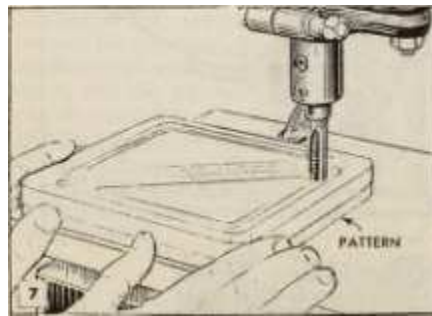
I Fence clamped to table guides work being routed. Routing mortise with aid of fence and stop blocks



Routing semicircular piece using waste part as jig. Pin aligns work for routing rim of circular piece



Pin-and-pattern jig for routing duplicate parts. Pattern Is placed over pin and guided around it



2 shows how to cut mortises. Note that stop blocks are fastened to the guide fence at each end to limit the length of the mortise. This method is particularly useful when making duplicate parts. Drill a hole at the start of the cut, using the router bit as a drill bit. Then with the bit in the hole, lock the spindle sleeve for depth and advance the work to the right-hand stop block. If the mortise is more than $\frac{1}{2}$ in. deep, drill a series of overlapping holes along the length of the mortise and then rout out the remaining wood.

When routing circular work, use a V-block jig as in Fig. 3. The work is held against the two sides of the vee and slowly rotated. One jig of this type may be used for a wide range of circle sizes by simply clamping it to the table at the required distance from the router bit. When the work is only a portion of a circle, a jig cut to the same radius as the work is used as in Fig. 4. If the circle has been carefully band-sawed, the waste portion of the wood will serve as a jig. In addition to the V-block method, routing around the rim of a circular piece of work is done with a pivot pin as in Fig. 5. The pin is set in a board clamped to the drill-press table. With this method, the work must have a hole through its center. However, if this is objectionable, a shallow hole can be bored in the underside of the work, and the disk pivoted on a very short pin.

When routing special shapes covering an area too large to be removed with a single pass of the router bit, a pin-and-pattern jig, Fig. 6, is used. A full-size pattern is cut from $\frac{1}{4}$ -in. plywood and tacked to the underside of the work. The pin, which can be either metal or wood, must be the same diameter as the router bit. It is set in a baseboard so its projection above the surface of the board is slightly less than the thickness of the pattern. Then the base is clamped to the table with the pin directly below the router bit. If the pin is not the same diameter as the router bit or is not aligned exactly with the bit, the work will not be an identical copy of the pattern. In use, the work and pattern are placed over the pin, as in Fig. 7. The bit is locked for depth by clamping the quill, and the outline of the pattern is routed in the work by guiding the cutout edges of the pattern against the pin. The remaining stock is removed by guiding the work freehand against the router bit until the entire space has been cleaned out. In some cases, it will be found helpful in keeping the pattern against the pin if the design is sketched on top of the work to serve as a guide.

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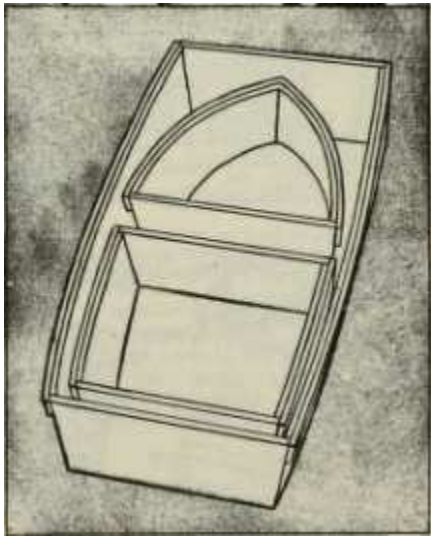
ROWBOAT

WHEN the three sections are taken ' ^ apart and nested, this 12-ft. rowboat occupies a space only 6% ft. long, and by virtue of its thin plywood construction is so light that one man can easily stow it on top of his car, using a suitable cradle to hold it. The boat is designed along standard lines, and construction differs only in the use of $\frac{1}{8}$ -in. plywood for sides and bottom. In fact, it is built up as a single-unit row-boat, and then sawed between the two double bulkheads to form the three sections.

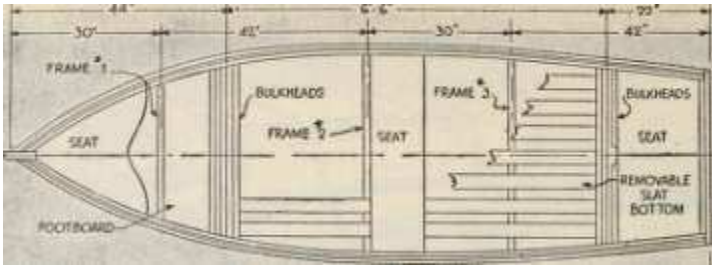
It is highly advisable to use waterproof plywood, if it is available. If not, the ordinary grade can be satisfactorily waterproofed by giving it three or four coats of paint or shellac, taking care to work it well into the exposed edges. If the wood is not thoroughly waterproofed, moisture will loosen the thin layers of wood and ruin the boat. In fact, all parts, whether directly exposed to the water or not, should be given two coats of paint or shellac before assembling them, and at least two more coats after assembling. Screws, also, should be seated in white lead. When not in use, the boat should be given an

application of paint more frequently than an ordinary boat.

First build the stem. Four wedge-shaped pieces are screwed to a central section of



1/2-in. pine having grain at right angles. The stem is fastened to a knee and keelson by means of galvanized carriage bolts, with heads countersunk. Next make the frames Nos. 1, 2 and 3, and the bulkheads. Note that there is a frame on each bulkhead. All frames are notched for chines, keelson and inwale, and frames Nos. 2 and 3 for the seat rail. The bulkheads should not be notched. In assembly, the keelson will be in three sections. Fasten the frames, bulkheads, stem and transoms to the keelson in their relative positions with galvanized or brass screws, and nail the keelson, with assembled frames, etc., temporarily to a plank in order to hold it rigid while installing the chine and inwale. Strips should



- 12-0'-
- BOW SECTION -
- AMIDSHIPS SECTION-
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SECTION THROUGH BULKHEADS

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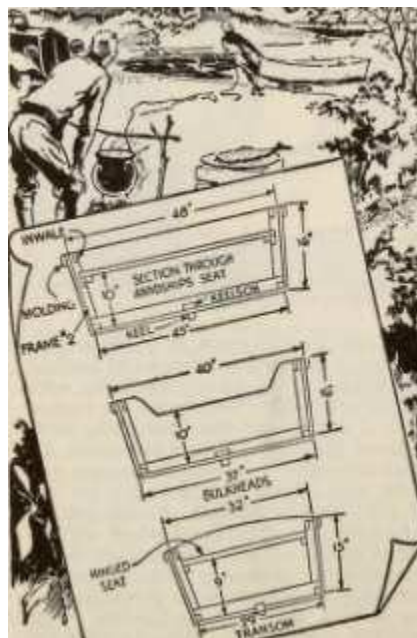
BOLT

I BINDING TAPE UPPED OVER 4 JOINT AND WHITE LEADED



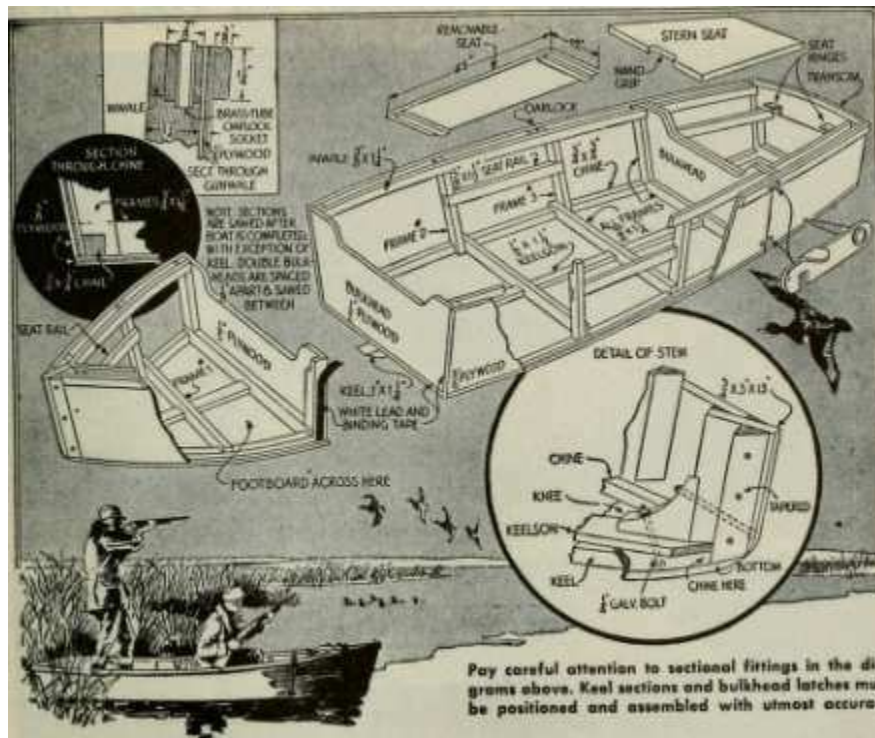
1^^

CHINE CAULKING DETAIL



be nailed across the tops of the frames, just below the inwale notches, to hold them in position, and removed after the side boards are on. The bulkheads, of $\frac{1}{4}$ -in. plywood, should be located about $\frac{1}{2}$ in. apart so that a saw can be inserted for separating the sections. After the plywood side boards are on, turn the boat upside down for putting on the bottom. This is cut from a single sheet of plywood. The panel is nailed temporarily to the bottom and the outline marked. It is then removed, sawed, and re- . placed with a finishing nail here and there r. after a strip of binding tape has been laid , over the joint and soaked in white lead. Bear in mind that the edge of the side board and chine must be smoothed with plane or sandpaper to make a flush and even joint. Fasten with $\frac{1}{4}$ -in. brass screws set about 2 in. apart. This will make an absolutely watertight joint. Bulkhead joints

should be made the same way. In making the oarlock, a piece of brass tubing is driven into a hole bored in a block that is fastened between side board and inwale. The tube, of course, should be large enough for the shank of the oarlock to turn freely, and should fit tightly in the wood block. The keel is bolted on after the hull sections have been sawed apart. This is necessary because of the tapered joints of the keel which lock the sections against an up-and-down motion. Bolts should be used only near the joints, and then through the keelson. Use galvanized carriage bolts with heads countersunk slightly in the keel. Elsewhere use long screws up through keel, keelson and into crossframes.



The seat rails are screwed to the frames in bow and stern sections, as shown above. The bow seat is screwed down, but the stern seat is hinged and forms a locker for fishing tackle, lunch, etc., out of the hot sun.

Pay careful attention to sectional fittings in the diagrams above. Keel sections and bulkhead latches must be positioned and assembled with utmost accuracy

The rowing seat is removable, which is necessary for nesting the bow and stern sections. A false bottom should be made for the amidships section to provide dry footing and protect the bottom of the boat.

ROWBOAT CAULKING

Tracing Wheel Aids in Caulking Seams of Leaky Boat

If you have no special tool at hand when the seams of your boat need caulking, you will find that a dressmakers' tracing wheel will serve the purpose. A tracing wheel can be purchased at most drygoods stores.



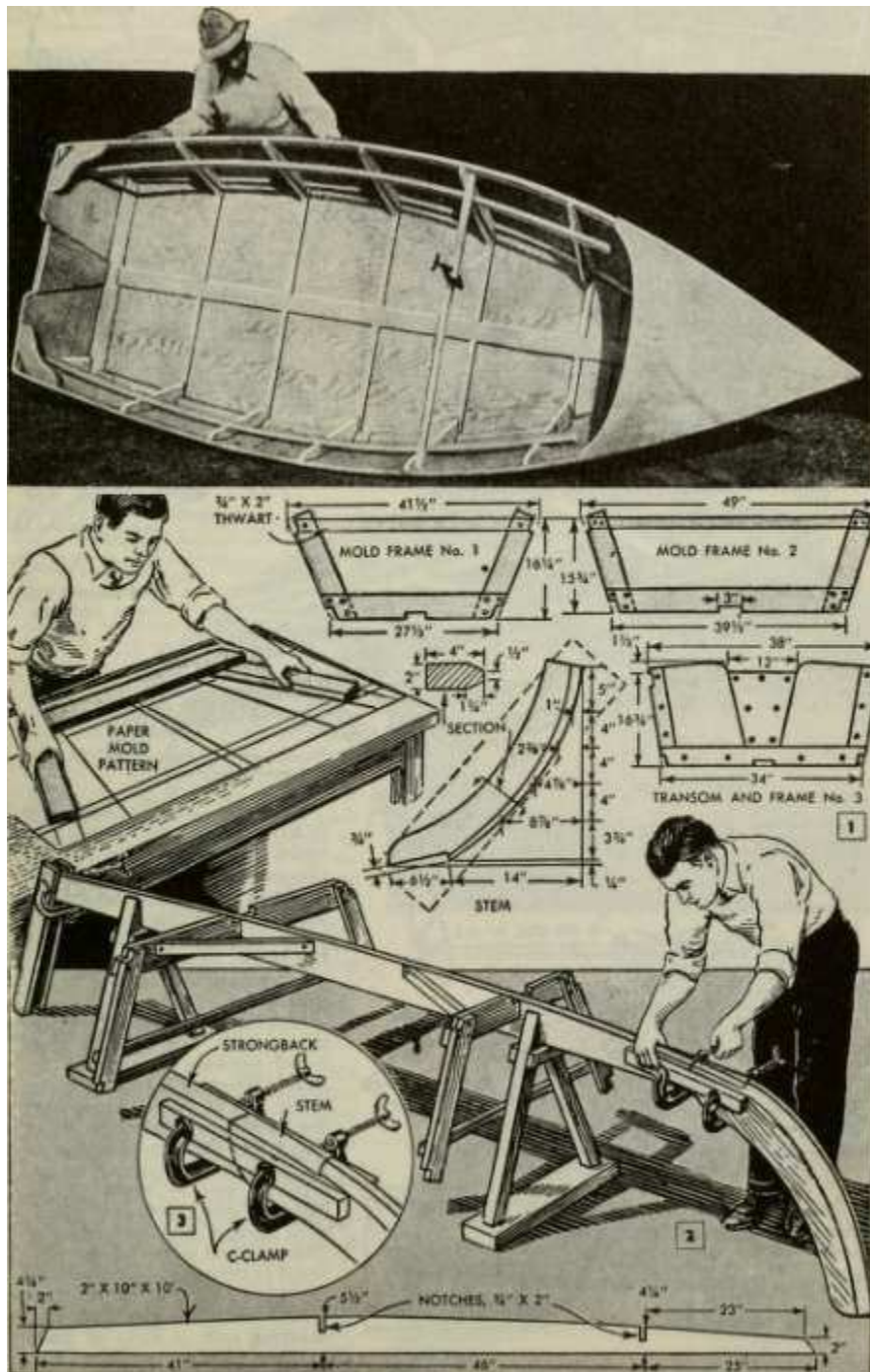
ROW BOAT Qcmied OH, Cga, loft



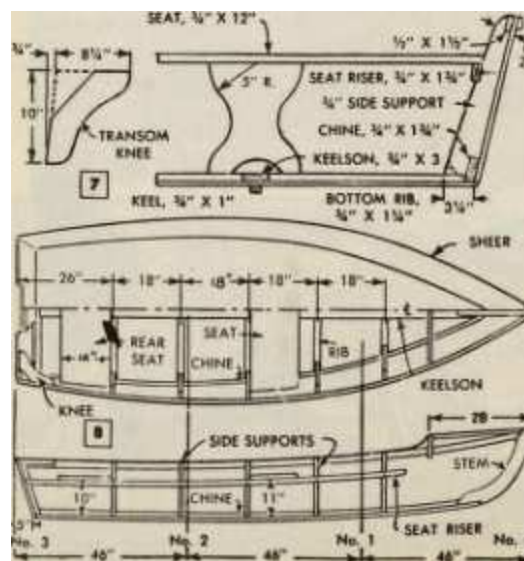
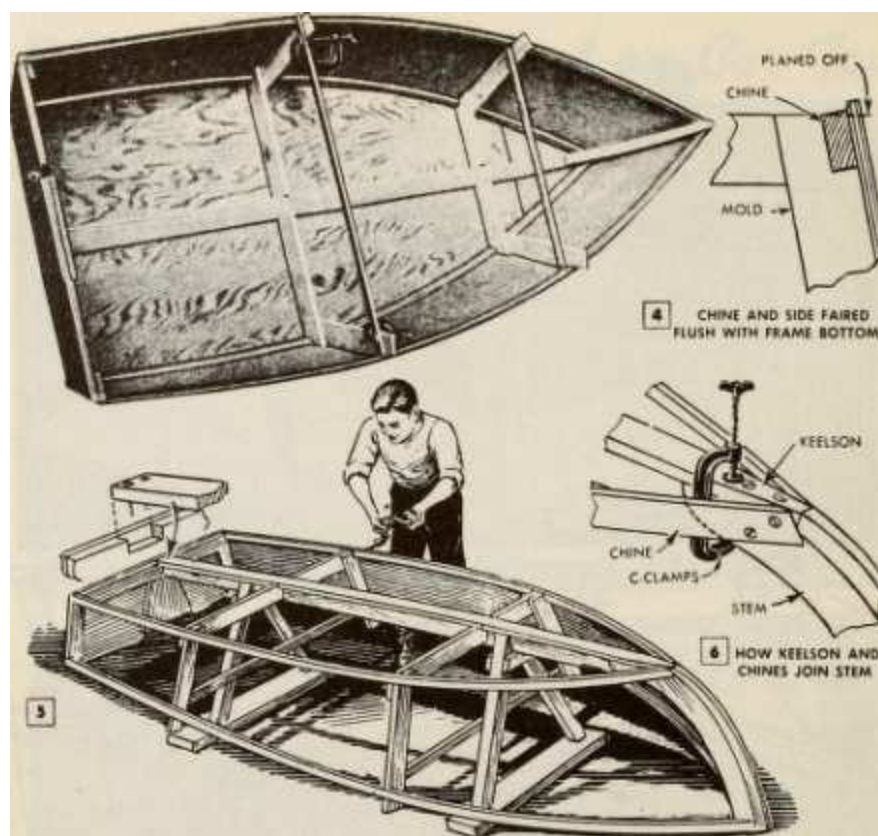
IF YOU CAN use a saw, hammer and *■ plane, you can easily master the construction of this simple car-top rowboat. There are no tricky planks to fit and no difficult rabbet to cut in the stem. Not counting the transom, only two mold frames are required, Fig. 1, and as the molds are only temporary, their assembly is not too important other than seeing that they are put together squarely. To assure this, make a full-size paper pattern of each mold and assemble the pieces directly on the patterns. The transom is $\frac{1}{2}$ -in. plywood. A notched frame is glued and screwed permanently to the inside face of the transom.

Next, the transom, molds and stem are fastened to a strongback or building board.

Fig. 5 gives a general idea of how the keelson, chines and sheer battens are fitted. These parts simply rest in the notches of the molds and are fastened only to the stem and transom. The keelson and chines are fastened to the stem as in Fig. 6, using 1%-in. No. 8 flat-head brass screws. One screw is used to fasten each aft end of the chines and sheer battens to the transom.



PLANED OFF CHINE .



The framework is now ready to be covered with marine plywood. Apply the sides first by clamping the plywood temporarily in place and marking it a little oversize for sawing. To make a watertight joint along the chine, coat it with marine glue and lay muslin tape in the glue. Then apply a second coat to the tape and attach the plywood with 1-in. No. 8 flat-head screws, spaced 2 in. apart. When dry, plane off the chine and plywood flush with the bottom of the molds as in Fig. 4. For the sake of economy, the plywood bottom can be applied in two or more pieces, Fig. 12, using copper clinch nails along a cleat-backed joint. The exposed edges of the plywood at the stem are faired into the curve of the stem, then coated with marine glue and covered with a strip of half-

MATERIAL LIST Lumber:

Waterproof plywood 1 PC. V4 X 48 in. X 10 ft.-Bottom 1 pc. V4 X 48 in. X 12 ft.-Sides 1 pc.

3/4 in. X 36 X 36 in.-Deck 1 pc. 3A X 18 X 48 in.—Transom

Spruce, fir, cypress or yellow pine 1 pc. 1/2 in. X 6 X 30 in.-Deck beam 1 pc. 34 X 3 in. X 10 ft.-Keelson

1 pc. 3/4 X 1 in. X 10 ft.-Keel

2 pcs. 3/4 X 13/4 in. X 12 ft.-Chines

2 pcs. 1/2 X 1 1/2 in. X 12 ft.-Sheer battens

1 pc. 3 X 3 in. X 6 ft.—Transom frame

2 pcs. 3/4 X 1/4 in. X 8 ft.—Side supports 2 pcs. 34 X 1/2 in. X 10 ft.-Bottom ribs 2 pcs. 34 X 1 in. X 12 ft.-Molding

Redwood, spruce 1 pc. 1 X 14 X 48 in.—Rear seat 1 pc. 3 X 12 X 48 in.—Forward seat Oak, ash or yellow pine 1 pc. 2 X 8 X 30 in.—Stem 1 pc. 1/2 X 1 X 24 in.—Stem molding 1 pc. 1 X 10 X 18 in.—Transom knees

1 pc. 1/2 X 53/4 in. X 10 ft.—Building board

2 pcs. 3/4 X 33/4 in. X 8 ft.—Scrap stock frames Hardware:

4 gross 1-in. No. 8 flat-head brass screws 1 gross 1 1/4-in. No. 8 flat-head screws

3 doz. 1 3/4-in. No. 8 flat-head screws 1 lb. 1 1/2-in. galvanized shingle nails 1 pr. oarlocks

3 brass lifting handles

1 mooring eyebolt

1/2 pt. marine or phenol-resin glue

Muslin tape

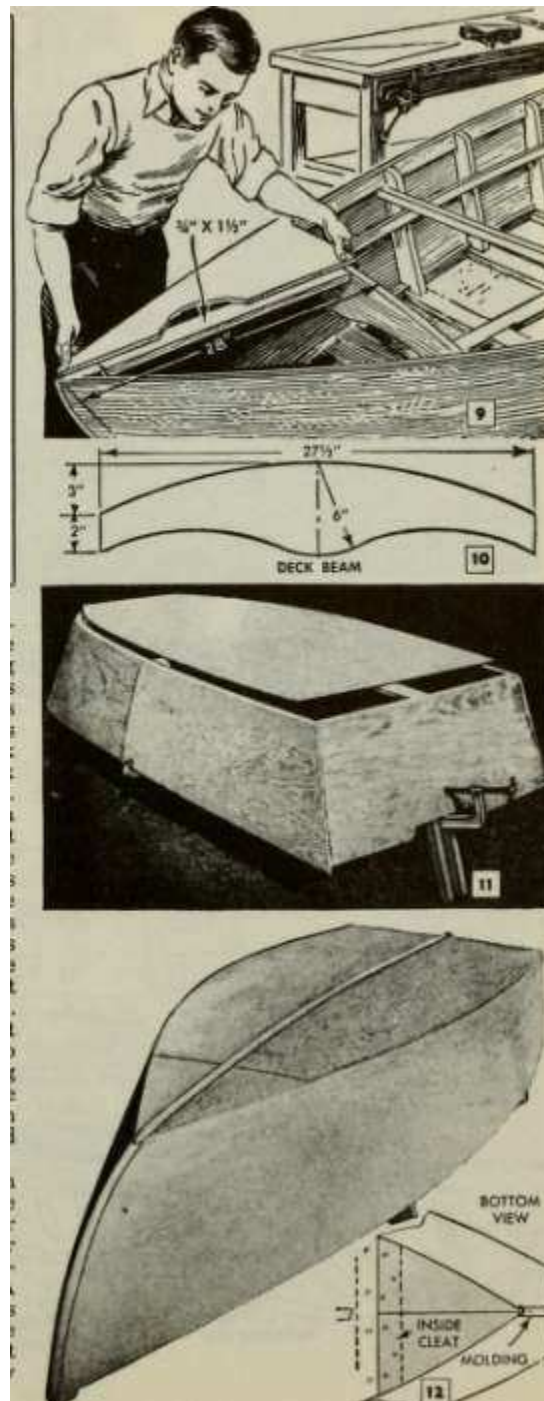
Paint and varnish

round molding to meet the keel.

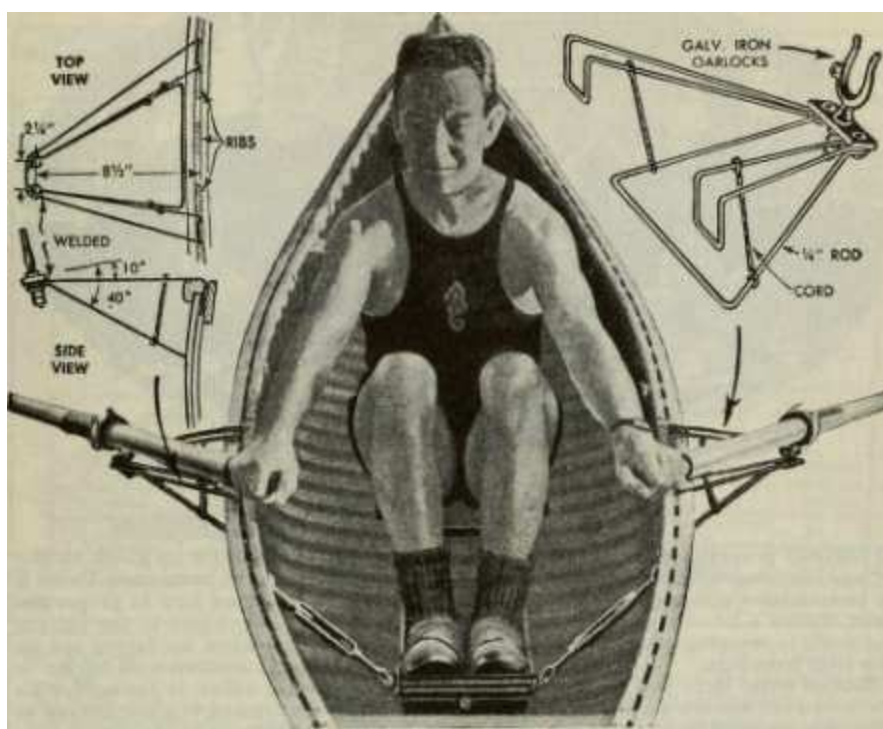
Now, lift the boat from the strongback, but before removing the molds, place a temporary cross brace between the sheer battens to maintain shape until the seats are installed. Complete the deck as shown in Fig. 9, fitting a deck beam. Fig. 10, 28 in. from the stem. Five supports are fitted to each side of the boat on the inside at points indicated in Fig. 8. These are notched to fit over the chines and sheer battens as shown in the sectional view. Fig. 7. This step is followed by installing the ribs which are notched to straddle the side

supports and simply butt against the keelson and chines. Copper or other rust-resistant nails are used to fasten the ribs to the plywood, the nails being clinched on the inside. Complete the boat by adding the transom knees, seat risers, seats, keel and the half-round sheer molding.

Use a copper bottom paint on the bottom of the boat and coat the rest of the wood above the water line with a lead-and-oil primer paint. Then finish with two full-bodied coats of deck enamel. A mooring eyebolt and three brass sash lifts screwed to the top edge of the transom provide convenient hooks for lashing the boat securely with rope to the car bumpers.



ROWING UNIT FOR CANOE



furniture casters. Foot plates and heel board are easy to make from 1/4-in. waterproof plywood. Toggles on the center partition turn down over one rib and prevent creeping of the seat frame while in use. The sliding seat may be flat but it is more comfortable if made from solid wood and shaped to saddle-seat form.

The axle keepers are designed to provide 3-in. travel for the axle, and the spacer plate which keeps the axles in parallel alignment can be made from aluminum. Sheet-metal clips bent around the axles and riveted to the plate hold the axles securely in place. To make the outriggers, you'll need about 20 ft. of 1/4-in. steel rod, one pair of size No. 1 galvanized malleable, U-type oarlocks and four 1/2-in. flat-headed stove bolts, with nuts and washers. The upper member of each outrigger spans three ribs, and the inner ends are bent to form hooks that fit snugly into the gunwale slots. One arm of each outrigger assembly

is a little shorter than the other so that when in position they rake forward slightly and have a 10-deg. downward tilt at the outer end. The 8 1/2-in. extension suggested is correct for the oars dimensioned. However, the extension may be increased somewhat if you prefer longer oars. The lower, A-shaped brace for each outrigger bears against the outside of the canoe hull about 5 in. below the gunwale. Fishline bindings over dowel spacers keep the assembly rigid when in place.

Oars for use with the outrigger should be 6 ft. 8 in. long over-all, with the blade and loom dimensions closely approximating those shown. Working a pair of regular oars down to these dimensions is quite simple to do. The leather and button should be located as shown. Bend the horns of the oarlocks so that the oars will not slip out when in rowing position, and key the oarlocks to the outriggers to prevent loss of the oars.



RUG WEAVING

Besides providing an excellent way of using up accumulated scraps of cloth, there's a lot of fun and profit in weaving colorful and serviceable rugs from rags.

Hooked rugs: Here you need a wooden frame—an old window screen will do—and a suitable weaving hook. Details A, B and C in Fig. 1 show three ways of assembling a frame. The peg arrangement permits adjustment to take rugs of different sizes, while the clamping method makes it easy

Three types — hooked, fluff, woven — all made from cloth scraps on simple wood "looms"

to take up slack as the work progresses. Detail E shows how to proportion the frame to the pattern and D shows a method for laying out an oval. The frame is covered with burlap or coarse linen and either is fastened with thumbtacks or stitched to cloth sleeves as in B. Keep the threads of the burlap running parallel with the frame and allow sufficient material to turn under and hem later. A rug hook is made by shortening the shank of an ice pick and filing a hook like

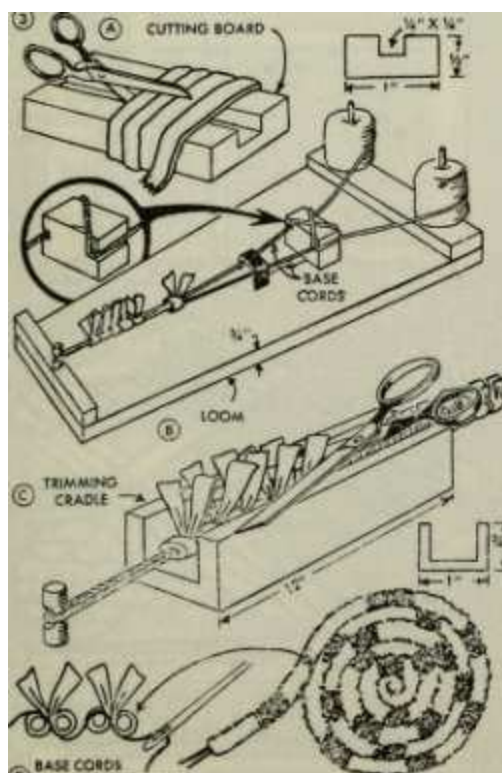
burlap tacked to frame, strands , "parallel with

'SIDES

ADJUSTING PEG i

CLOTH ^..f SLEEVE

CORNERS CLAMPED



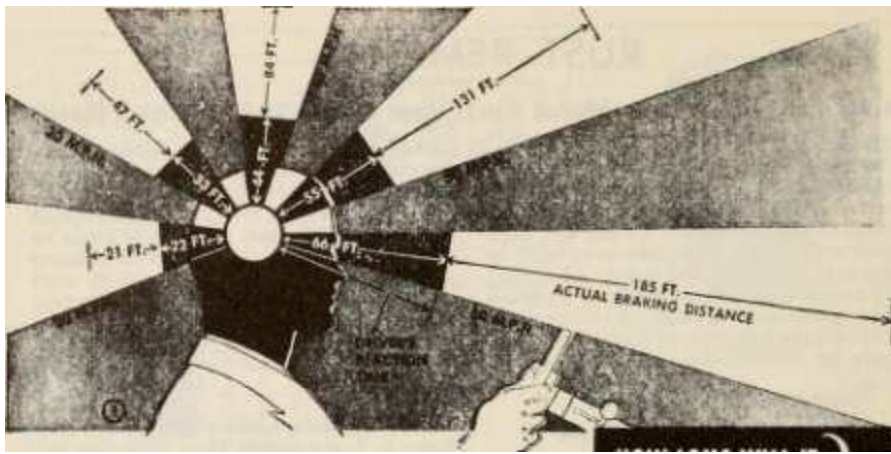
^ . BASE CORDS

(S' ARE SEWCO TOGETHER

that shown in Fig. 1, detail F.

Suggestions for appropriate patterns can be found by thumbing through magazines. Enlarge the pattern to full size and draw it on the burlap with a crayon. Then, working outward from the center, push the hook through the burlap, G, and pull a strip of $\frac{1}{2}$ -in. cloth up through to form a loop $\frac{1}{2}$ in. long, H. Push the hook through again, three strands from the first insertion, and draw up another loop, I.- When a row has been completed, the loops can be clipped, J, or they may be left uncut. From here on it is simply a matter of repeating as before. Certain portions of the design can be made to stand out in relief by allowing the loops to extend higher than the others.

Fluff rugs: Although similar to a hooked rug, the fluff rug is a continuous strip of material wound in a spiral and sewed together as in D, Fig. 3, to form a thick, soft rug. First, wind a $\frac{1}{2}$ -in. strip of cloth around a grooved board and cut as in A. Then with a loom made and rigged with carpet warp as in B, begin attaching the cloth strips to the warp. These are not tied but simply brought up between the cords as at D and pushed together as you



SAFE DRIVING

NE of the major factors in the safe operation of a car is knowing how far it will travel before coming to a stop after the brakes have been applied. Knowledge of this fact is important if the car is to be kept under complete control. The distance required to stop a car on a good, dry pavement is surprising, especially at higher speeds, and this may account for many of the accidents that occur. As shown in Fig. 1, at 20 m.p.h. the average car in good condition will come to a standstill after traveling 43 ft. from the time the driver receives a signal to stop. The signal may be a car dashing out from a side street; a child running out from between parked cars or, in the country, it may be a car on the wrong side of the road when rounding a blind curve. At 40 m.p.h., 128 ft. of clear space is required to stop the car, and at 60 m.p.h., a total of 251 ft. is required.

Of course, the brakes are not actually applied from the moment you receive a signal to stop. There is a period, generally called reaction time, which is the interval required to act after you receive a warning to "step on the brakes." This time varies from driver to driver, but it is estimated at approximately $\frac{1}{4}$ second. This means that at 20 m.p.h. a car will travel 22 ft. before the brake pedal is touched. At higher speeds the car will travel even greater distances before the brakes are set. For example, at 40 m.p.h. the car will travel 44 ft. and at 60 m.p.h. the distance is 66 ft. before the driver applies the brakes. These figures apply to cars in good condition traveling on well-paved, dry roads. Under poor conditions, much more allowance should be made for stopping the car.

Another factor in safe driving is the recognition of signs giving directions, Fig. 2. Rectangular signs are used to give traffic directions, round signs indicate a railroad crossing and a diamond-shaped sign means that the driver is to slow down. A square sign contains either information or a warning and an octagonal sign means a stop. Knowing what the shape of the sign means helps

HOW LONG WILL IT TAKE YOU TO STOP

A CAR SUDDENLY DARTS OUT OF A SIDE STREET . .



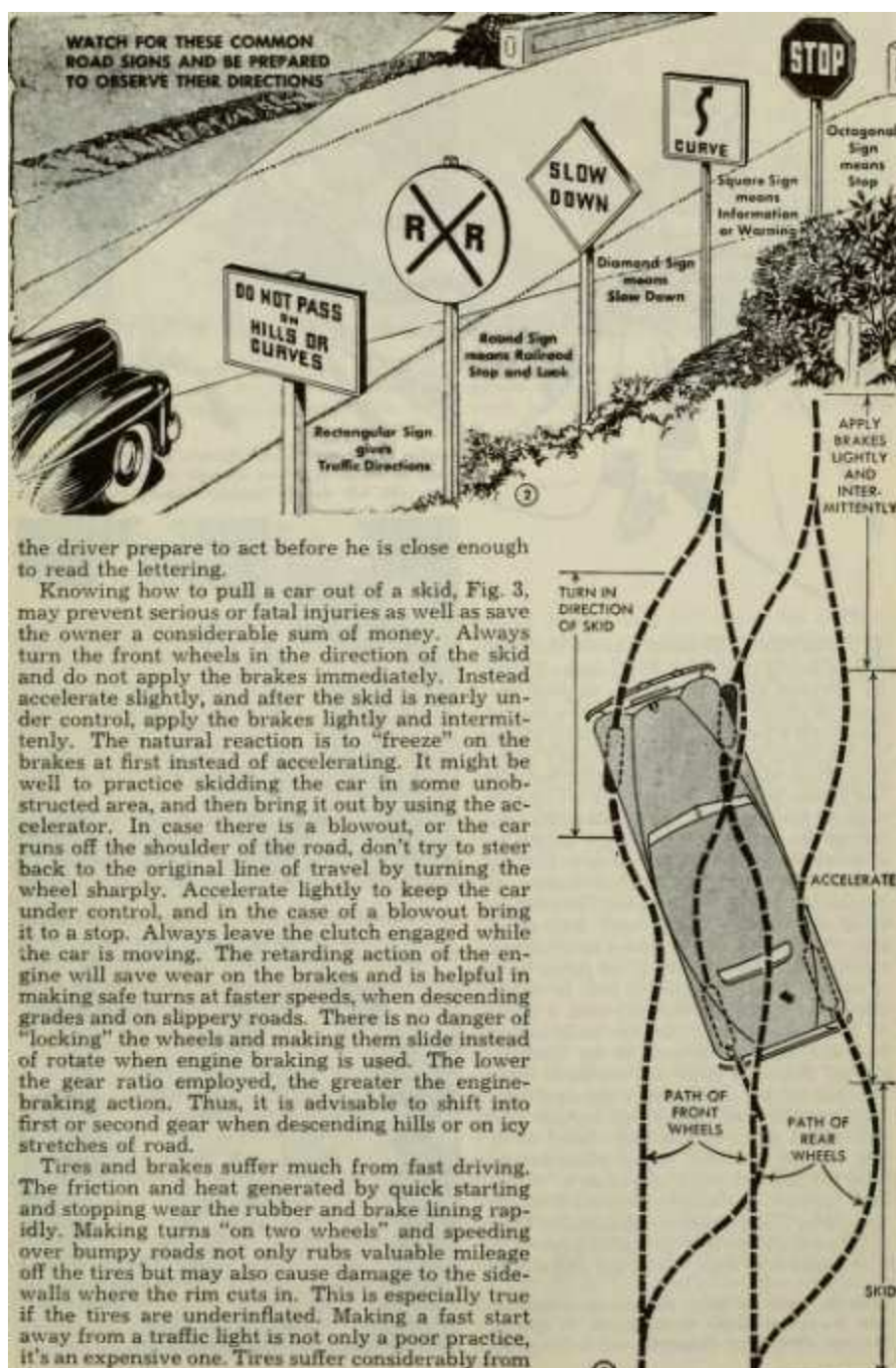
OR A CHILD RUNS OUT
FROM BETWEEN PARKED CARS



WHAT'S AROUND THE CORNER? COULD YOU STOP IN TIME?



WATCH FOR THESE COMMON ROAD SIGNS AND BE PREPARED TO OBSERVE THEIR
DIRECTIONS "\



the driver prepare to act before he is close enough to read the lettering.

Knowing how to pull a car out of a skid, Fig. 3, may prevent serious or fatal injuries as well as save the owner a considerable sum of money. Always turn the front wheels in the direction of the skid and do not apply the brakes immediately. Instead accelerate slightly, and after the skid is nearly under control, apply the brakes lightly and intermittently. The natural reaction is to "freeze" on the brakes at first instead of accelerating. It might be well to practice skidding the car in some unobstructed area, and then bring it out by using the accelerator. In case there is a blowout, or the car runs off the shoulder of the road, don't try to steer back to the original line of travel by turning the wheel sharply. Accelerate lightly to keep the car under control, and in the case of a blowout bring it to a stop. Always leave the clutch engaged while the car is moving. The retarding action of the engine will save wear on the brakes and is helpful in making safe turns at faster speeds, when descending grades and on slippery roads. There is no danger of "locking" the wheels

and making them slide instead of rotate when engine braking is used. The lower the gear ratio employed, the greater the engine-braking action. Thus, it is advisable to shift into first or second gear when descending hills or on icy stretches of road.

Tires and brakes suffer much from fast driving. The friction and heat generated by quick starting and stopping wear the rubber and brake lining rapidly. Making turns "on two wheels" and speeding over bumpy roads not only rubs valuable mileage off the tires but may also cause damage to the side-walls where the rim cuts in. This is especially true if the tires are underinflated. Making a fast start away from a traffic light is not only a poor practice, it's an expensive one. Tires suffer considerably from this type of driving.

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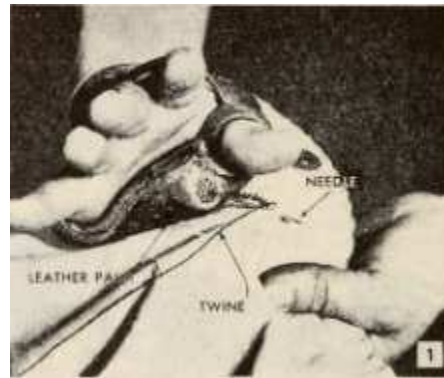
SAIL MENDING



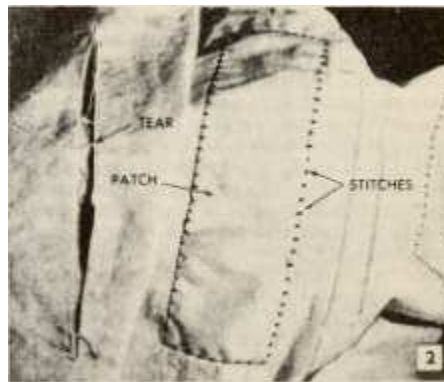
pXPERIENCED sailors avoid the risk -*—' of being caught with a torn sail aloft by keeping sailcloth always in good repair. A short tear takes the drive out of a sail and a bad tear, which usually starts with a small rip in the canvas may leave your boat wild a long way from help or the home port. Mending sail will come easy to the amateur yachtsman after he learns the tricks of handling a sailmak-er's needle and how and where to use the flat and herringbone stitches employed by the professional sailmaker. Inventory of a sailmaker's "ditty bag" will show that it contains one or more sailmaker's needles, a "palm thimble" or palm, as it is called, a sharp knife, a ball of twine (it is never called thread) and a lump of sailmaker's wax. In the sailmaker's loft, the wax is referred to as "composition." All these items are available from marine-supply dealers at a nominal cost. The palm is made from soft leather and fits in the palm of the right hand as in Fig. 1. An

indented metal plate sewed into the leather palm serves as a "thimble" for forcing the heavy needle through the cloth. The procedure pictui-ed in Figs. 1, 2 and 3 shows how to apply a patch to a straight-line tear, using the flat stitch,

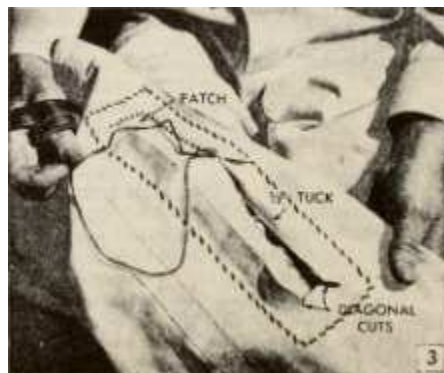
With the patch in place, the canvas is reversed and the sail is sewed to the patch. At ends of the tear, cloth is cut diagonally and tucked under

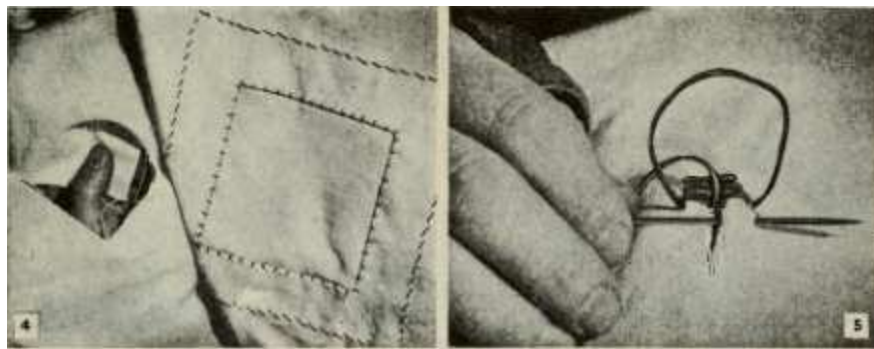


Leather palm vt/ith metal thimble protects sailmaker's hand as needle is driven through sail and patch. Pressure with left thumb "breaks" needle into the clear



How a patch is sewed over a straight-line tear similar to one at left. Sewing the patch to the canvas is the first step in making the repair. Edges are tucked under





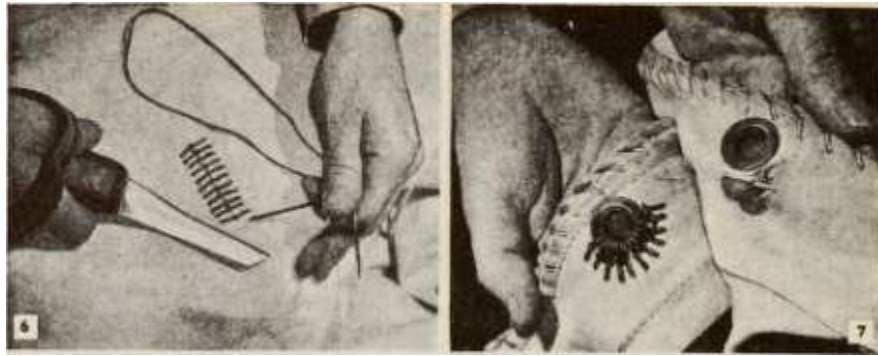
Patch at the right repairs an L-shaped rip similar to one shown at the left. Procedure is the same as that employed in repairing the straight-line tear

Minor tears, both straight and L-shaped, are mended with herringbone stitch like that shown above. No patch is used. Herringbone stitch is self-locking

also called the round stitch. Note the position of the left hand in Fig. 1. The cloth is grasped between the thumb and the left fore and middle fingers. As the needle passes through the cloth in making the stitch, it touches the middle finger and simultaneously the thumb presses the cloth down, causing the point of the needle to emerge or "break." This finger action produces stitches of a uniform length and, although the procedure requires considerable skill, it can be mastered with practice. Fig. 2 shows a patch sewed over a short straight-line tear like that shown at the left in the photo. First, the patch is sewed to the sail with the edges tucked under. Fig. 2. Then the sail is sewed to the patch, Fig. 3. Diagonal cuts are made at each end of the tear and the edges of the sailcloth are tucked under as the sewing proceeds. In all photos showing the stitches, black twine was used for purposes of clarity. In actual practice, white twine is used almost exclusively. Figs. 1, 2 and 3 do not show all the movements in completing a stitch, nor do they show the natural position of the hands in actual practice. As an example, the fingers of the right hand. Fig. 1, are shown much higher than they would be in normal procedure. This has been done in order to show clearly the position of the needle. After the needle has been pushed through by the palm, it is grasped firmly by the thumb and forefinger of the right hand and pulled through to tighten the

twine. In mending sail, the twine is never tugged at the completion of the series of stitches. It is merely pulled taut and to a light tension. The twine is never knotted, at either the beginning or finish ends. In all patching, the edges of the patch, as well as the torn edges of the sail covered by the canvas patch, are tucked under to prevent fraying of the cloth. Ordinarily, the patch is cut from material of the same weight as that of the sail and it is cut to a width that will extend it at least 3 in. on each side of the tear before tucking. Sailmakers use several methods of locating the patch correctly over the tear. A short tear offers little difficulty but a long rent or one that is L-shaped requires more care. Fig. 4. It's important to make sure that the patch extends an equal distance beyond the limits of the tear at both ends. About 3 to 4 in. is a good average. Long patches can be tacked temporarily to the sail with several stitches at intervals along the length. Old sailmakers frowned on this practice, however, as they found there is a possibility of a

patch applied in this way causing unequal tensions in a large sail. Perhaps the best practice in applying fairly large patches is to spread the sail on a flat surface, smooth all the wrinkles out of the canvas, then mark the location of the patch on the cloth. The marks on the sail make it easy to locate the patch as the sewing proceeds. Sailmakers usually start the first stitch about halfway along the length



The completed herringbone stitch with the finish end about to be cut off. Some sailmakers return the twine through several loops before cutting the end

The herringbone stitch also is used to repair tears around grommets. In making the repair, one loop of each stitch passes around the grommet ring as shown

of the patch. The initial stitch goes down through the sail and patch and back up and the twine is pulled through until only about 3 or 4 in. of the end remain. This free end is then folded under the tuck where it is locked in place by subsequent stitches. At the finish end of the stitch, the twine is carried back under several loops and cut off.

The herringbone stitch, Figs. 5 to 8 inclusive, is used in repairing snags, small rips and tears, both straight-line and L-shaped, and also for mending the tears that develop around grommets, Fig. 7. It is self-locking and exceptionally flat and, when carefully made by a skilled workman, it results in a neat and permanent repair. Figs. 5 and 6 show the start and end of the

stitch and Fig. 8 details the procedure quite clearly. Note in Fig. 8 that the dark-shaded portions of the twine are on top of the cloth while the lighter portions are underneath. With this in mind, it is easy to follow the course of the needle and twine above and below the cloth. The stitch is started as in Fig. 8 by forcing the needle through the cloth, then back up and through to the underside again. Next, the twine is carried to a point just about opposite the end of the tear and about $\frac{1}{2}$ in. to one side of it. Then the twine is brought up through and across to an equal distance on the opposite side of the tear where it is passed again through the cloth and brought up through the tear. From here it is taken over the first loop and down through

the tear. This completes the first individual stitch. The trick in making a smooth, neat repair without bulges or wrinkles is simply to maintain an even tension on the twine as the individual stitches are made. A common method of ending the stitch is to cut the

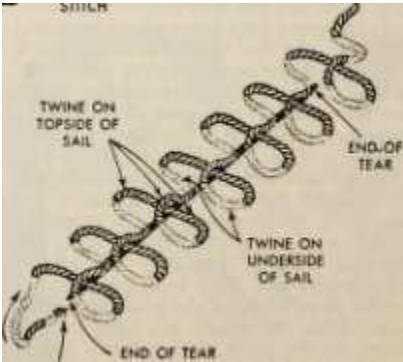
twine as in Fig. 6 about Va in. above the cloth. Another acceptable method is to pass the needle through several loops and then cut the twine just back of the last loop. In repairing the cloth around grommets, one loop of the stitch passes around the grommet ring. Fig. 7. This type of grommet repair cannot be considered permanent, although it will last throughout a full season unless the sail is old and weakened by weathering. Holding the sail on the lap permits free left-hand movement.

HERRINGBONE STITCH

TWINE ON

TOPSIDE OF

SAIL



TWINE ON

UNDERSIDE

OF SAIL

END OF TEAR

START OF STITCH

SAILING SCOW



SAILING SCOW

DESIGNED especially for those who want a practical, unpretentious sailboat which is easily and quickly built at low cost, Solution is simply a scow with hull refinements that enable it to carry a 21½-ft. stepped mast and about 140 sq. ft. of sail. The plywood bottom curves in a long, unbroken sweep from the stem block to the transom, while the sides curve out to the beam width back of midships and then fair in to the transom in a smooth, flat curve. Because of these construction refinements, the hull rides easily and planes smoothly when you pick up a good breeze on the long reach of the tack. The unbroken curve at the gunwale adds to its trim, seaworthy appearance.

Selected fir or spruce is used for the frames, and all fir plywood used in the hull should be of the waterproof marine grade. The solid stock for the

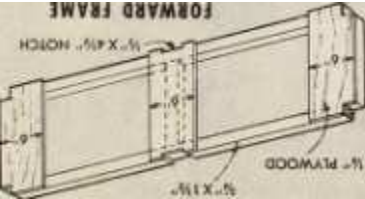
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The first step is to lay out and cut the side panels, Fig. 3. Note that both side and deck panels are cut from four 4 x 9-ft. sheets of y4-in. plywood. To lay out the sides of the hull, two sheets are laid on the floor, end to end, and marked according to the drawing. Stations for the eight frames also are marked. The deck panels, Fig. 4, are laid out from the waste plywood after cutting the sides. To do this, it is necessary to flip over the panels, end for end. Being made up of two separate pieces, the deck and side panels are butted together and joined with butt blocks, as indicated, gluing and screwing them in place. Be sure to assemble the side panels so that one is right hand and the other left. After the glue is dry, clamp the panels together and plane the edges so that both units are identical in size and shape.

Fig. 1 details assembly of the frames. Scrap plywood left from the panels is used to serve as gusset plates in covering the frames. In the case of the mast frame, both sides of the frame are completely covered to give sufficient strength to support the mast. The headstay frame is a solid 8-in. board, notched top and bottom. Note that

V4" PLYWOOD

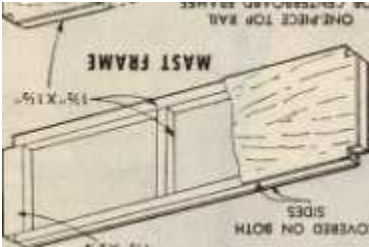


-1/2"X41/2" NOTCH

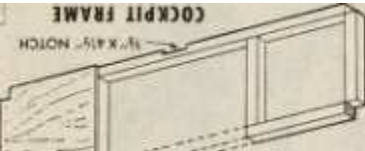
FORWARD FRAME

11/2"X21/2"

COVERED ON BOTH SIDES

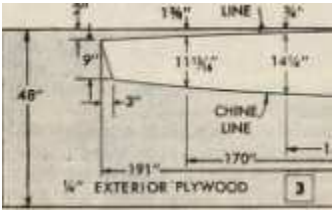
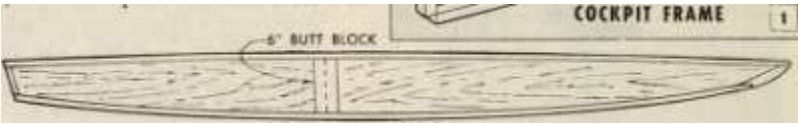


ONE-PIECE TOP RAIL FOR CENTERBOARD FRAMES, --, -r



V1" X 4V," NOTCH

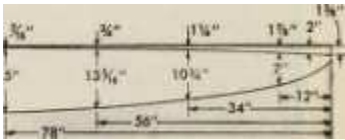
COCKPIT FRAME



H SIDE-PANEL ASSEMBLY

K

.Jfe" ,o"

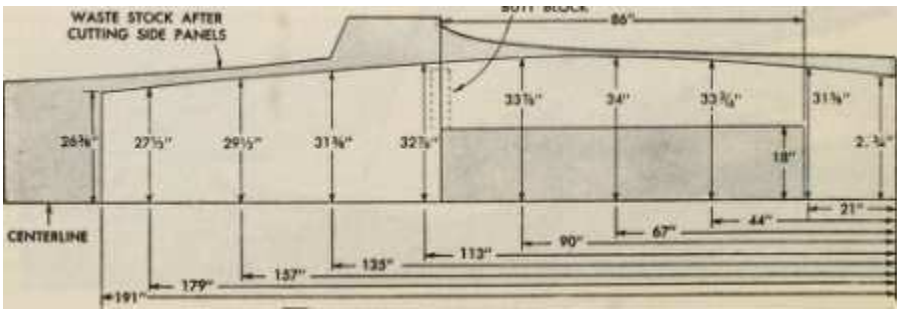


BUTT^ JOINT , 124"

15%" 15"

EXTERIOR PLYWOOD \J] LAYOUT OF SIDE PANELS

WASTE STOCK AFTER CUnING SIDE PANELS



[Tj LAYOUT OF DECK PANELS

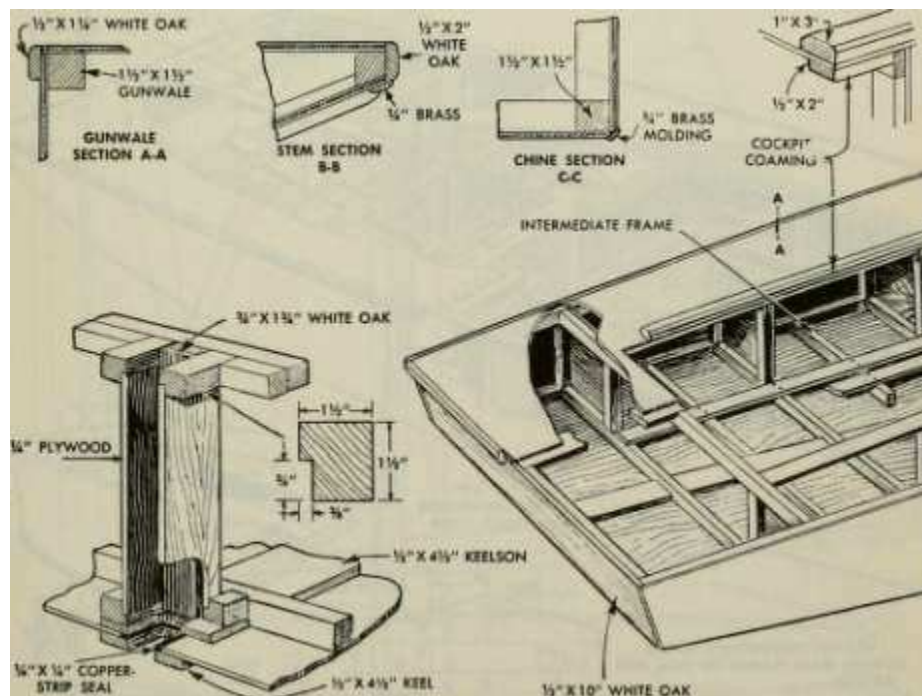
the mast frame is not notched for the keelson, and that the cockpit frames are left open at the top. All frames are notched squarely at the corners for chines and gunwales, but it should be remembered that, both forward and aft, the chines as well as the gunwales actually meet the notches at a slight angle because of curvature of the parts at these points. For this reason, the edges of the fore and aft frames, including the faces of the notches, must be faired (planed) so that the plywood panels fit the chines and gunwales on a flat plane. Use a block plane and fine wood rasp for this job.

With the frames completed, chines and gunwales are next fitted to the inner surfaces of the side members of the hull. Notice in Fig. 2 that these conform to the shape of the sides and are fitted with a nose block at the stem and a vertical cleat at the transom.

Now, temporarily assemble the sides of the hull to the deck. The side panels are forced to take the curve of the deck panel by drawing in the ends with bar clamps or a twisted rope loop. The lower edges of the panels are held the correct distance apart by clamping a strip across the width

at a point directly under the deck butt block. In this way, the butt block and the strip act as spreaders which force the side panels to take a uniform bend in each direction from this point. When this is done, the frames can be fitted to the chines and gunwales individually.

After fitting the frames and the keelson, the bottom panels can be installed. First, turn the assembly over, place on a level floor and block up the stem and transom until these parts check square and true. Plane all exposed surfaces and edges so that the curves are uniform, then locate the bottom panels with the edges centering on the keelson. Plane the edges to get a tight fit. Remove the panels and apply marine glue to all joining surfaces. Then replace the panels in the order removed and fasten with screws driven in flush. After the glue is dry, attach the keel and turn the hull over. Remove the deck panel so that you can install the deck beams, intermediate frames and the filler block between the headstay and stem piece. After these parts are installed as in the cutaway view shown below, cut the opening for the centerboard and fit the parts of the centerboard well as



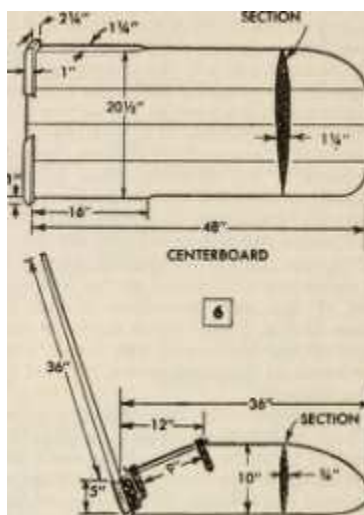
'^"X'^" COPPER-STRIP SEAL

V4"X10" WHITE OAK

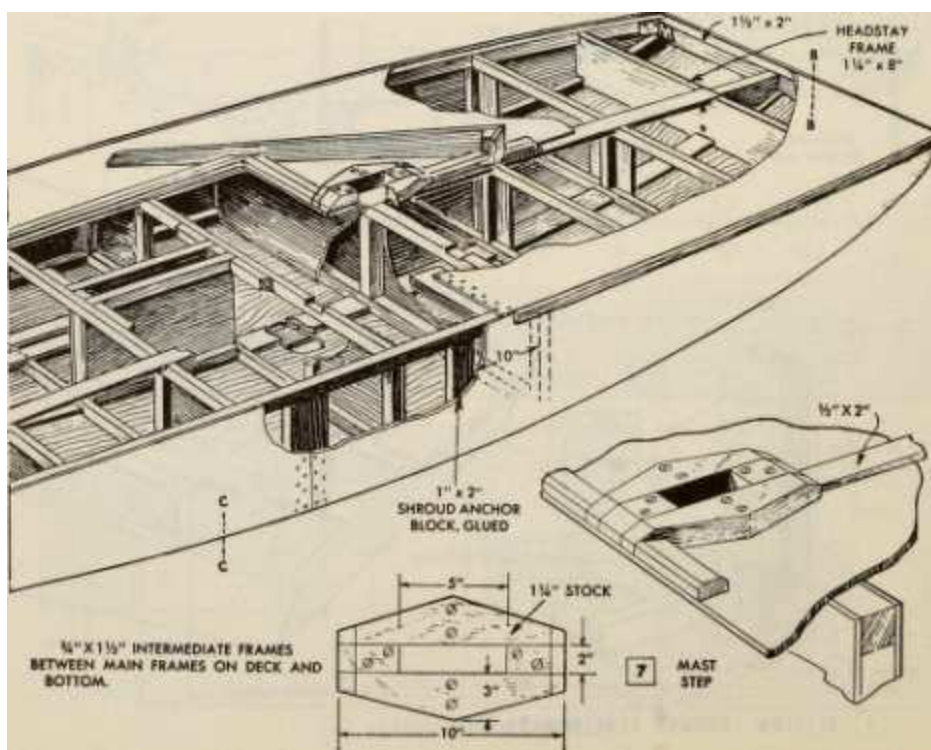
\J] SECTION THROUGH CENTERBOARD WELL

in Fig. 5. Special care must be taken to build a watertight joint around the lower opening of the well. Set all the joining parts in marine glue and be sure that all joints fit tightly. The copper sealing strip, Fig. 5, serves the dual purpose of providing a watertight seal at the joint and also protecting the wood against wear from the centerboard. Finish the hull by adding the oak transom, cockpit coaming, deck splashboards, mast step, Fig. 7, rudder and centerboard. Fig. 6, and the moldings and rub rails as shown in sections A-A, B-B and C-C, Fig. 5.

The mast, Fig. 11, is of box-section construction with filler blocks spaced as indicated. Sides of the mast are faced with $\frac{1}{8}$ -in.-thick stock, which is applied with cold resin glue. The mast has a 6-in. rake aft from a point 16 ft. above the deck. Figs. 8 and 10 show the method of attaching the mast stays to the mast and to the deck tangs. Fig. 9 details the gooseneck which carries the boom. To anchor each stay to the tangs, first insert the end through the hole in the tang and seize it tightly, using several turns of No. 16-ga. copper wire at a point about 4 in. from the end, as in



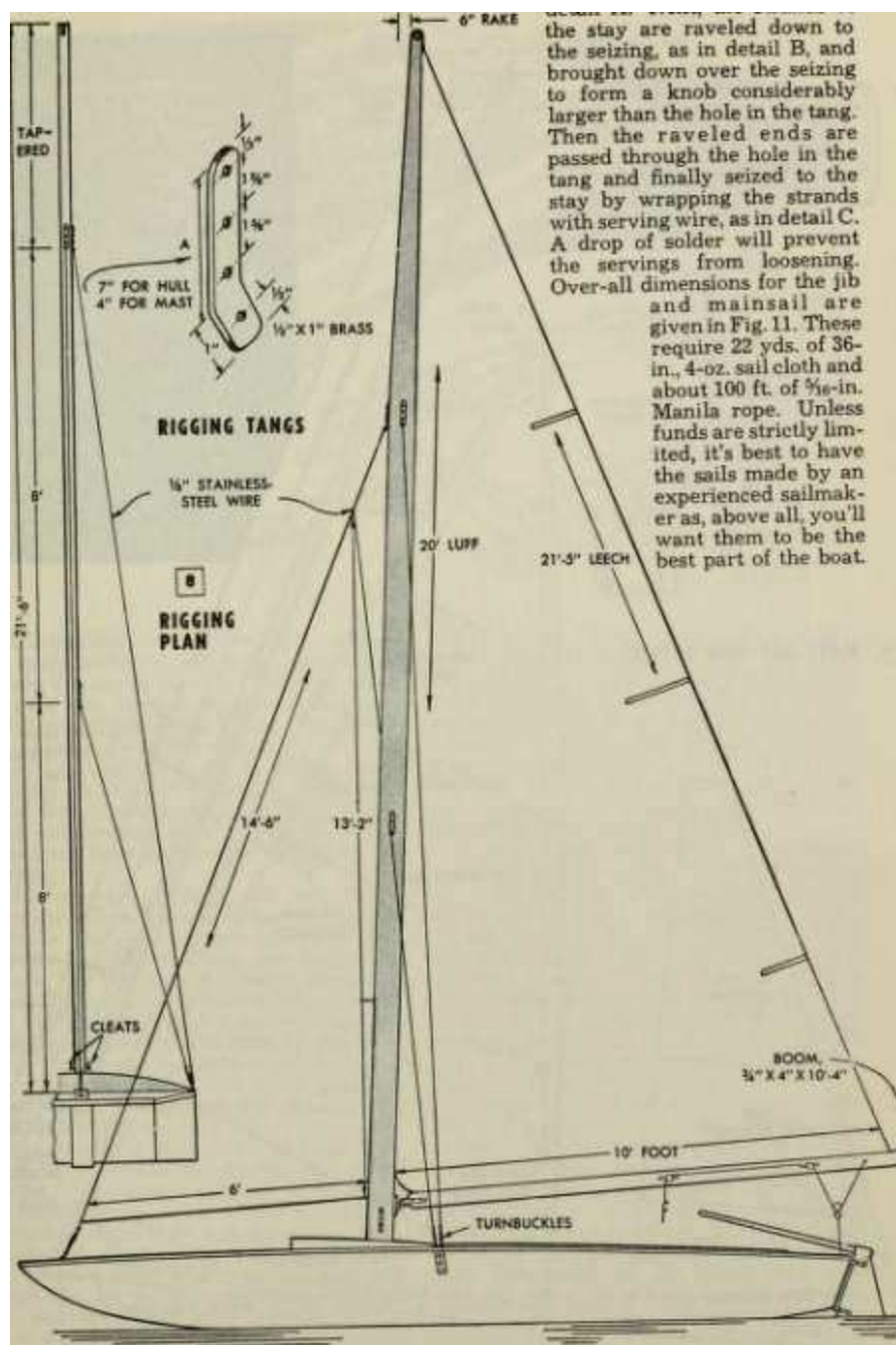
1 1/2" X 2"



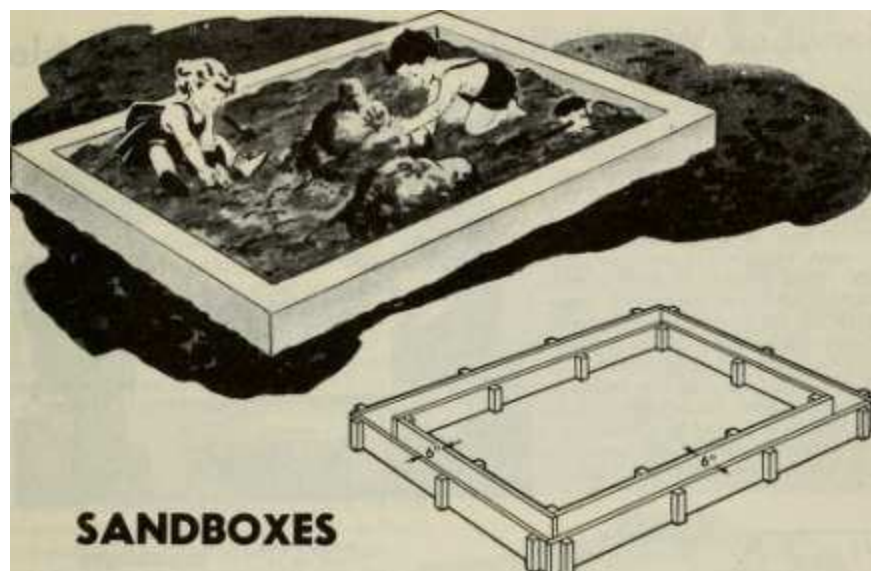
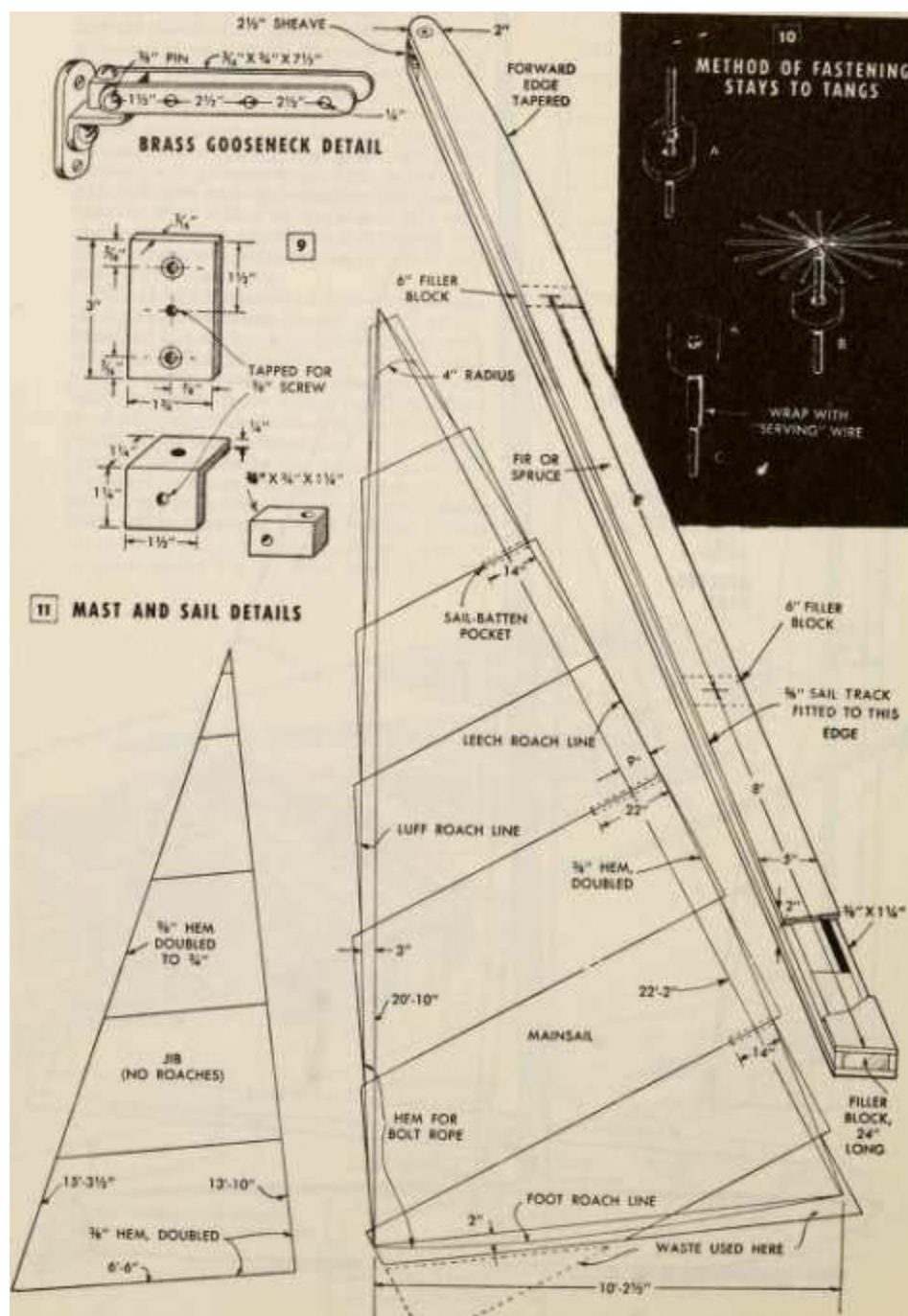
1/4" INTERMEDIATE FRAMES BETWEEN MAIN FRAMES ON DECK AND BOTTOM.

RAKE

detail A. Next, the strands of the stay are raveled down to the seizing, as in detail B, and brought down over the seizing to form a knob considerably larger than the hole in the tang. Then the raveled ends are passed through the hole in the tang and finally seized to the stay by wrapping the strands with serving wire, as in detail C. A drop of solder will prevent the servings from loosening. Over-all dimensions for the jib and mainsail are given in Fig. 11. These require 22 yds. of 36-in., 4-oz. sail cloth and about 100 ft. of 6-in. Manila rope. Unless funds are strictly limited, it's best to have the sails made by an experienced sailmaker as, above all, you'll want them to be the 21'-5" LEECH \ best part of the boat.



2'/j" SHEAVE ^%" PIN <-VXV4"X7'/,"



/CHILDREN'S sandboxes are usually ^-^ made of wood, but a concrete enclosure as illustrated above can be better fitted in with the surrounding landscape and buildings. Children are seldom fussy about the appearance of the area in which they play, but they'll perk up in delight when they see an attractive modern sandbox all their own. Children enjoy playing in the sand, and besides, it's a wonderful way to keep them from the dangers lurking on the streets.

The concrete sandbox not only has a more attractive appearance but also is more durable. The sand playpen can be built to any dimension, fitting into any desired location. The box should be large enough to accommodate several children. For a working example we have suggested the size of the enclosure to be 5 ft. wide and 15 ft. long. This is not a standard measurement for all sandboxes, but will serve as a basis from which to estimate the material for your particular needs.

The sidewalls should be at least 6 in. thick to withstand weathering and rough usage. In building a sandbox of concrete, the first thing to do is to dig a trench to a depth of about 18 in. and about 8 in. wide. The trench should be wide enough to allow the wooden form to slip in and still give about 6 in. for the concrete filler. The form can be improvised from used boards or planking that is 3/4 to 1 in. thick. The stakes for holding the form rigid are cut from 2 X 4-in. boards cut into lengths of

about 4 1/2 ft. These can be very rough.

In laying out the forms in the trenches, be sure that the tops of the boards come even with each other, and that the inner surface is as smooth as possible. The inside planking of the form should be well drenched before the concrete is poured. Coating the surface of the boards with crankcase oil helps greatly in removing the form from the finished concrete.

In estimating the amount of material needed for the project, expect about 4 cu. ft. of concrete to be required for each running ft. A box as suggested here, 5 x 15 ft., will require 48 cu. ft. of concrete. The mixture is made in the proportion of 1 sack of cement to 4 1/2 of sand and 4 of pebbles. The pebbles should range in size from 3/4 in. to 1 in. in diameter. All told, about 10 sacks of cement, 25 cu. ft. of sand and 40 cu. ft. of pebbles will be required for the sandbox measuring 5 x 15 ft.

For the best results, don't forget to mix the dry materials well before adding the water. The concrete should be of quaky consistency for pouring. Don't pour the whole batch into the form at once. Set in about 3 or 4-in. layers, tamping each layer down firmly to release any air bubbles that may have formed. Lay the concrete mixture even with the top of the form and allow to set for about 2 hrs. and then smooth out the surface with a straightedge. Allow the concrete to set for about 48 hrs. Remove the wood forms and stakes, and fill in the space used by the forms.

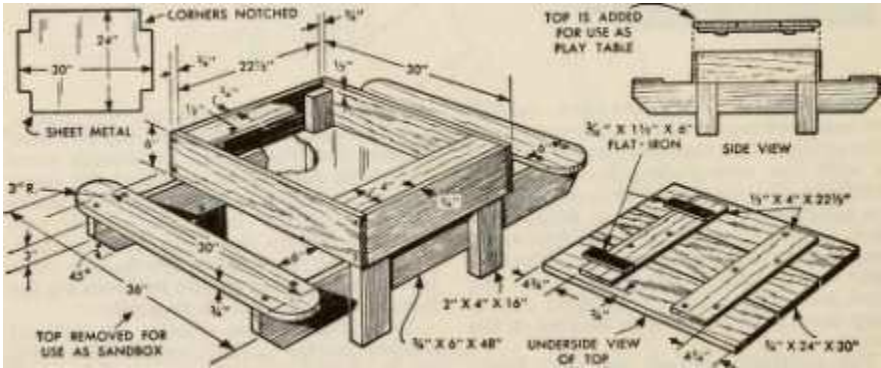
Sandbox With Built-in Seats Doubles as Table

Resembling a miniature picnic table, this novel sandbox features a removable top which can be replaced when it rains or used to convert the box into a neat outdoor play table. Except for the bottom which is sheet metal, the entire box is constructed from common lumberyard material, the legs being pieces of 2 x 4, the ledges at the ends 1x4, with practically all the rest of the members being cut from 1x6 stock. A piece of 1/2-in. waterproof plywood will serve as a top or one can be built up from several boards. Two flat-iron cleats, fastened to the underside, serve to hook the top in place. R. V. Stewart, Cleveland, Ohio.



"T 1 _ ^ ^ CORNERS NOTCHED

24"



/

TOP REMOVED FOR USE AS SANDBOX

Va" X 24" X 30"

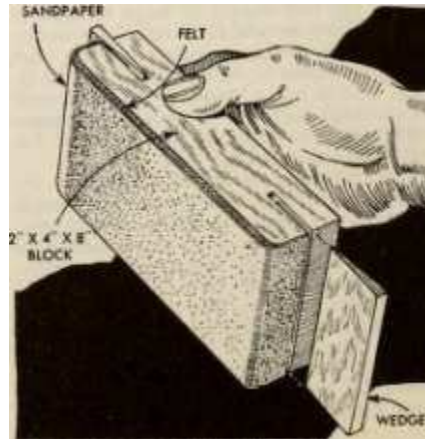
SANDER BLOCK

Paper Wedged on Sanding Block

Changing paper on this sanding block is just a matter of removing and inserting a couple

of thin wedges. Made from a short

piece of 2 by 4-in. stock, the block is slotted at each end to receive the ends of the abrasive paper which is held by pressing a couple of thin hardwood wedges into the slots. Covering the bottom of the block with thin felt provides a smooth, resilient backing for the paper.



SANDERS

"pvESIGNED to take a standard 6-m. ■^^^ abrasive belt, this lathe sander is an inexpensive unit capable of handling any type of work ordinarily run on a small belt sander. Accurate adjustment for tensioning and tracking is furnished by means of an alignment bar fastened to the underside of the base, which tilts the sander laterally to align the idler with the driving drum, and, at the same time tightens the belt.

Construction should be started by making the two drums. The larger of these— the driving drum — is made from three pieces of 1%-in. stock, glued and screw-fastened together to permit turning as can be seen in Figs. 2 and 4. The drum is fitted on a standard 3-in. faceplate. The idler can be built up similarly or can be turned from a single solid block. Both

UNIT TAKES STANDARD 6-IN. BEITS AND HAS

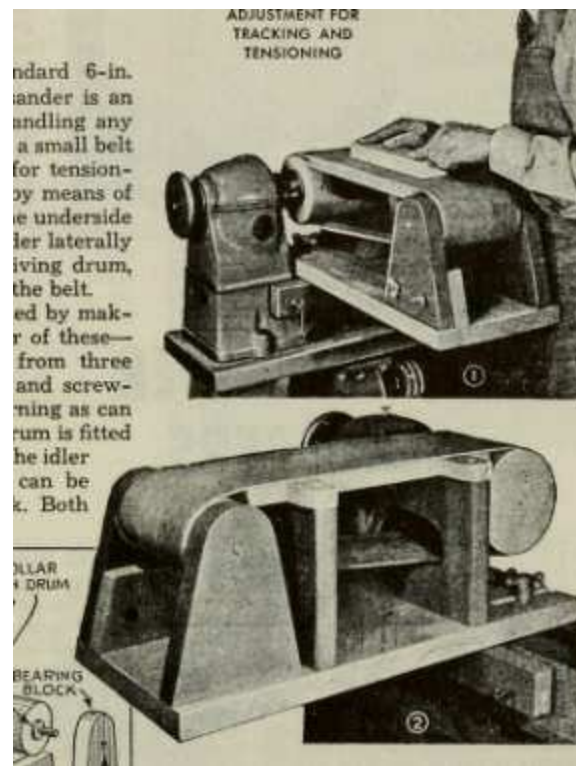
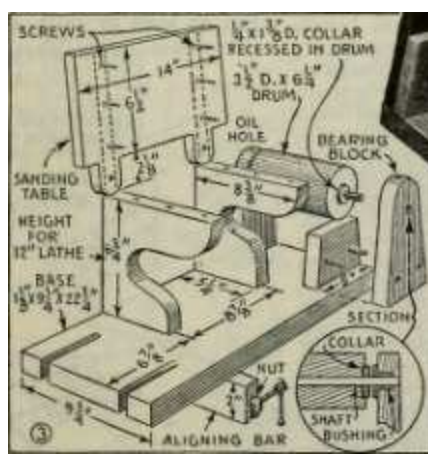
ACCURATE

ADJUSTMENT FOR

TRACKING AND

TENSIONING





Standard 6-in. sander is an handling any a small belt for tension- by means of e underside ler laterally iving drum, the belt. ed by mak- r of these— from three and screw- ning as can rum is fitted he idler can be k. Both

drums are 6 1/2 in. long. Wood stock for the other parts is 1 1/4 in. thick with exception of the sander table which is of 3/4-in. stock. Because of the short cross grain on the sanding-table supports. Fig. 3, it is advisable to make these of plywood.

To fit the sanding belt in place on the completed unit, the removable bearing

block at one end of the idler is taken off by loosening the wing nuts which hold it in place, Fig. 1. The belt is then slipped over the drums, after which the bearing block is replaced and the nuts tightened. The unit is fitted to the lathe by means of two studs which engage in the slot in the lathe bed. Tension is provided by means of the two screws fitting through the aligning bar. By turning one screw more than the other, proper alignment of the belt for straight tracking is assured. The adjusting screws can be obtained from small C-clamps. The screws are pointed at the free end with a file and engage in shallow holes drilled in the side of the lathe bed. Adjustments are made with the base loosely clamped to the bed, the base bolts being tightened after

tensioning and tracking have been done.

For certain types of work a fence is handy. This is easily cut from scrap stock and attached to the soUd bearing support of the idler with screws. It is not shown in the details as most users will want to adapt it to their own special needs. Use a stick belt dressing on the driving drum to prevent slipping of the belt on heavy work. An occasional application will be ample. Special sizes of sanding belts are made in various grades to suit the craftsman's needs.

TWO POWER SANDERS

TJERE ARE TWO homemade senders that will handle ■*•*■ practically every sanding job in the home shop. One is a combination band, disk and drum sander, while the other is a conventional 6-in. belt sander. Both can be made inexpensively, using standard parts along with odds and ends. Band Sander: Figs. 1 and 2 picture and detail the construction of the combination sander. The framework is assembled from pieces of channel iron, the upright being 3-in. channel welded to a 6-in. channel base. Note that the upright is located 2 in. from one edge of the base and that a 3 by 8-in. opening is cut in the base to permit belting and driving the machine from below. The dimensions given for the frame accommodate a 45-in. standard belt. If a longer one is used, the upright must be lengthened. Holes are drilled in the top surface of the base for mounting two ball-beaiing pillow blocks. These carry the drive pulley and double-end shaft which drive the sanding belt and the disk. The arm, which carries the upper bearings, also is a length of 3-in. channel iron with the web cut out at one end, as shown, and the flanges spread apart to fit over the flanges of the channel upright. The arm is drilled and pivoted to the upright with a Va-in. bolt, after first being drilled for two bronze-bushed pillow-block bearings and a tensional rod. In drilling the mounting holes for the pillow blocks, extra care must be taken to assure perfect alignment of both upper and lower bearings. This is important, as there is no provision for adjustment of sanding-belt trackage other than the use of shims under the pillow blocks. It is also important that the holes foi- the tensional rod in both base and arm be aligned accurately to avoid the necessity of shimming the pillow blocks. The hole for the rod in the arm must be elongated slightly with a round file to provide clearance. The rod, which is threaded at each end, is anchored to the base by two nuts and a lock washer. A washer and nut on the upper end provide a shoulder for the end of a %-in. i.d. compression spring which bears against

One model combines three sanders in one machine driven by a single motor. The other, a 6-in. belt sander, employs standard shaft hangers for bearings, and features positive tension adjustment. Both machines can be built at nominal cost from scrap parts

BACKING PLATE SHEET METAL

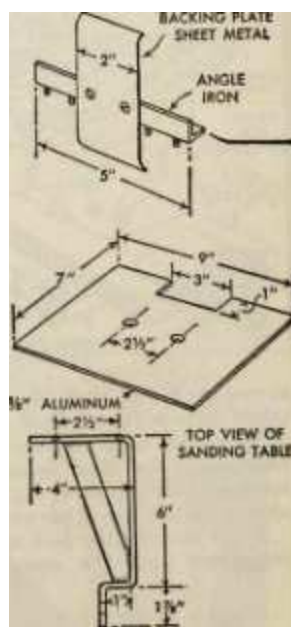
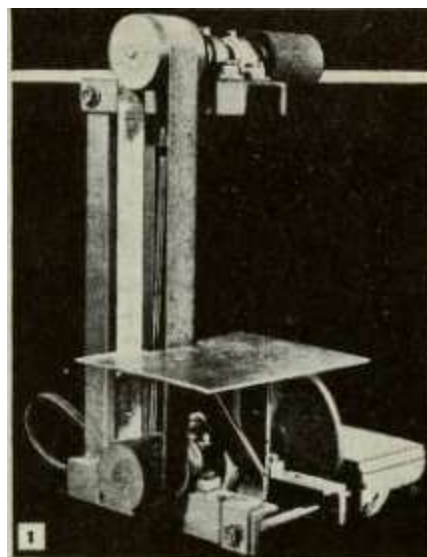


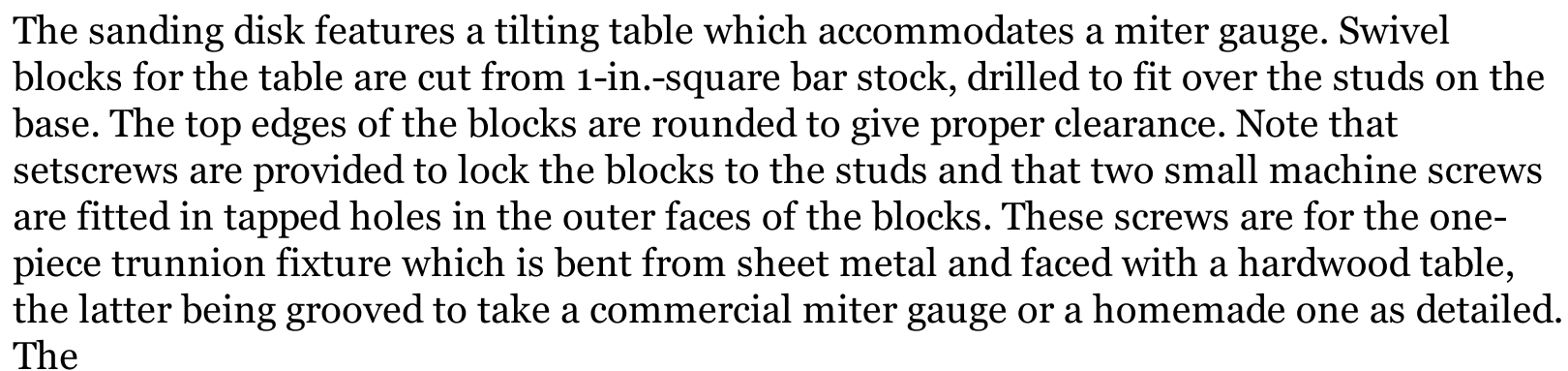
TABLE SUPPORT

the underside of the arm. The location of the nut and washer must suit the spring used and tension desired. The end of the rod is capped with a handwheel, which is tightened or loosened to regulate belt tension. The flanges of the channel-iron base are drilled for three studs on which the swivel blocks and table bracket are mounted. Two of the studs are formed by a single rod, one end being threaded before tack-welding the rod in position.

The idler and driving drums for the belt Sander are turned to size and balanced right on their shafts. This is done by drilling a 2-in. hole in the end grain of hardwood blocks and pinning each block to its shaft with a nail driven crosswise through an undersize hole in both drum and shaft. Note that the drums are crowned $\frac{1}{4}$ in. The sanding-belt table, which can be either metal or wood, is supported by a 90-deg. bracket bent and welded from $1\frac{1}{4}$ -in. flat iron. This bracket is mounted on the threaded base stud. Note that the table is



TENSIONAL ROD\ /

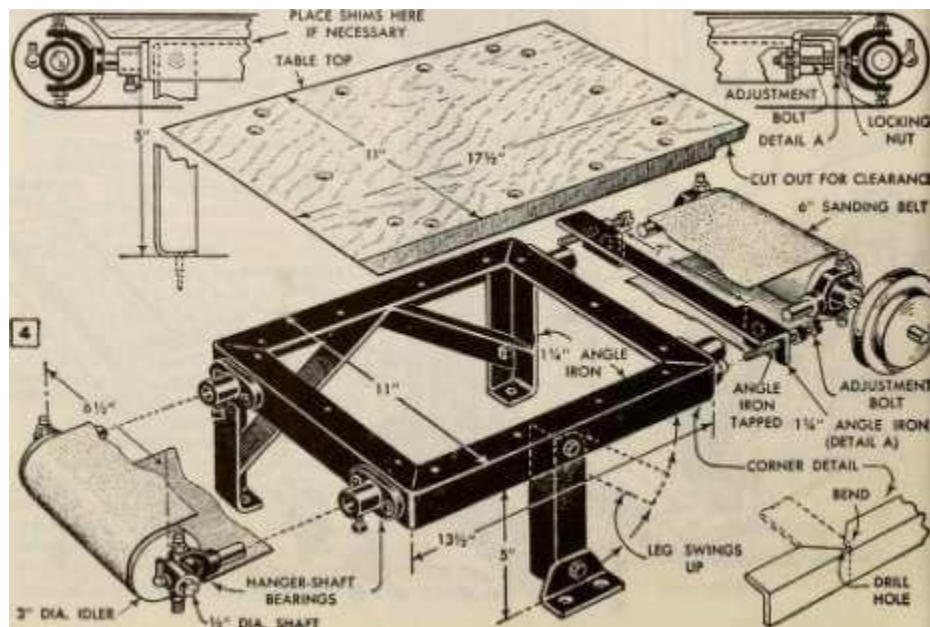


front edge of the wooden table is beveled 45 deg. The sanding disk is a piece of plywood

faced with sandpaper and mounted on the shaft by means of a small faceplate. A regular metal sanding disk can be purchased if you wish. Likewise, a commercial unit can be used for the drum on the idler shaft.

Belt Sander: This sander uses standard y2-in. shaft hangers and a 6-in. endless sanding belt. The base parts of the hangers are bolted to the ends of a metal framework that is shaped and braced as shown in Fig. 4. The top part, to which a wooden table is bolted, is bent from one piece of angle iron by drilling a small hole at the point of bend and then cutting out a 90 deg. segment or gusset as indicated in the detail. Welding the mitered corners, as well as the two rear legs, to the frame, makes an exceptionally sturdy assembly. However, the parts can be bolted together. Note that the front leg pivots to permit mounting and removing the sanding belt.

The idler and driving drums are balanced by pinning and turning them on their shafts. Belt tension and tracking adjustment are provided by a piece of angle iron drilled and tapped at each end for a V4-in. adjusting screw and locknut. This piece



3" DIA. IDLER

also is drilled at each end to slip loosely over the post of each hanger. It may be necessary to cut out a 7-in. section of the angle iron to give clearance for the driving drum. Belt tension and tracking are maintained simply by turning in or backing out the adjusting screws, as the ends of the screws bear against the frame and force the hangers inward or outward. You may find it necessary to rabbet the underside of the wooden table to provide clearance for the tension fixture. Also, shims may be required between the frame and wooden table to bring the surface flush with the sanding drums. While the sander is shown without a fence in Figs. 3 and 5, one can be made by clamping angle-iron supports to the rear legs of the machine and fastening a hardwood fence to them to overhang and clear the sanding belt.

Note that the pillow-block bearings of the band sander, Fig. 2, and the shaft-hanger bearings of the belt sander, Fig. 4, are fitted with either oil cups or grease fittings. A $\frac{1}{2}$ -hp. motor is sufficient to operate the band sander. How-

Tape Handles to Hold Small Work Against Disk Sander

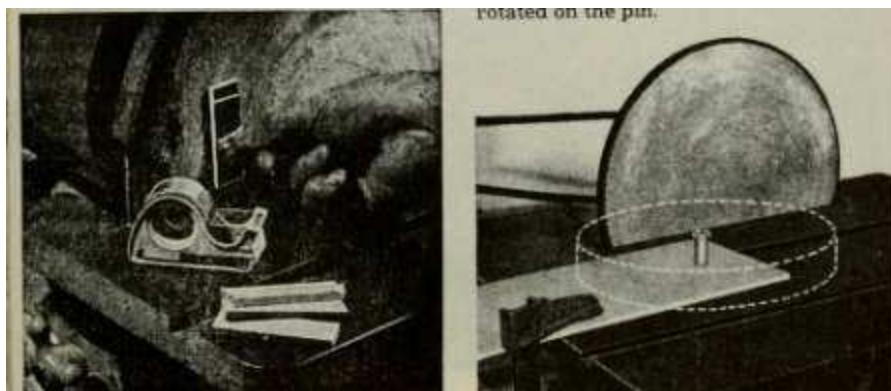
"When small pieces must be finished on a disk sander, strips of adhesive or cellulose tape will provide handles for holding the work. Fold each strip in the center and stick the ends to the work to provide a tab. The same piece of tape can be used several times.

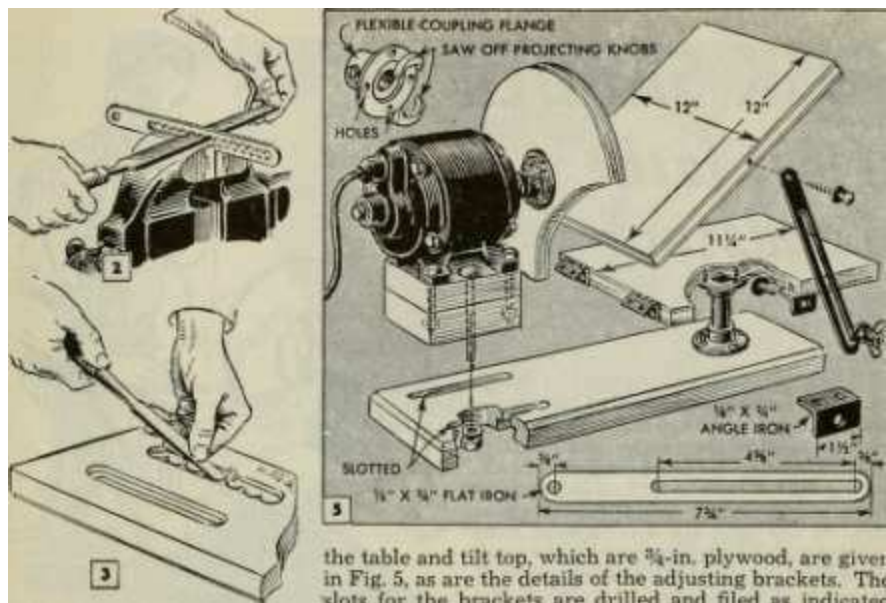
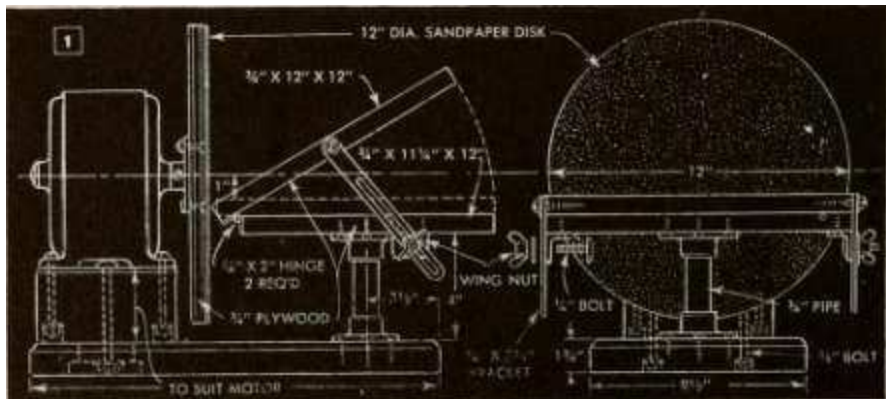


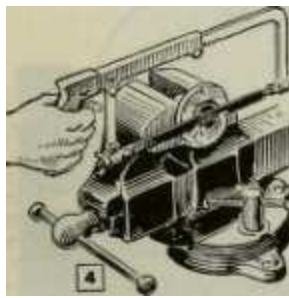
ever, the belt sander should be driven by a motor of at least $\frac{1}{2}$ or $\frac{3}{4}$ hp., especially when coarse sanding belts are used.

Wheels Made on Disk Sander

Needing a couple of thick, wooden wheels for a piece of lawn furniture, but not having a handsaw in his shop to cut them, one home craftsman made this jig and "turned" the wheels on his disk sander. The jig is simply a $\frac{1}{4}$ -in.-plywood base drilled near one end to take a short dowel. Each wheel is roughed out and drilled at the center to fit over the dowel. Then the jig is clamped loosely to the sander table, and the wheel held against the sander until it has been cut to the desired diameter at one spot. The jig is clamped in this position and the work is rotated on the pin.



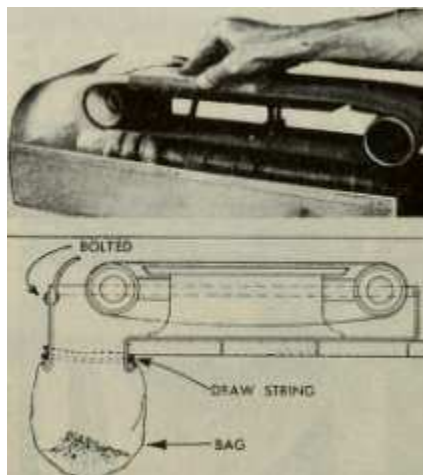




the table and tilt top, which are $\frac{1}{2}$ -in. plywood, are given in Fig. 5, as are the details of the adjusting brackets. The slots for the brackets are drilled and filed as indicated in Fig. 2. Two butt hinges are used to secure the tilt top to the table, allowing the former to overlap the latter as shown in the left-hand detail of Fig. 1. A flexible-coupling flange is used as a mounting for the sanding disk. The face is cut off flush with a hacksaw. Fig. 4; or, to insure a disk that will run true, it can be faced in a lathe if the latter is available. To complete the sander, cut a $\frac{1}{2}$ -in.-plywood disk 12 in. in diameter and bolt it to the flange with flat-head screws, countersinking the holes so the heads will be a little below the surface of the disk. Glue on the sandpaper and finish the unit with gray or black paint. For convenience in operation, a toggle switch can be mounted on the base or block to control the operation of the motor instead of using a switch in the line or on the wall.

Metal Tray Under Belt Sander Reduces Dust in the Shop

By mounting your bench sander in a shallow, sheet-metal tray, such as the one shown, dust in the shop will be reduced considerably. Note that a shield is bolted to one end of the tray, and that a bag is tied over an opening directly under the shield. This catches the dust at the point where most of it is thrown off the belt. Dust that gathers in other parts of the tray is pushed into the bag when necessary.



DISK SANDER

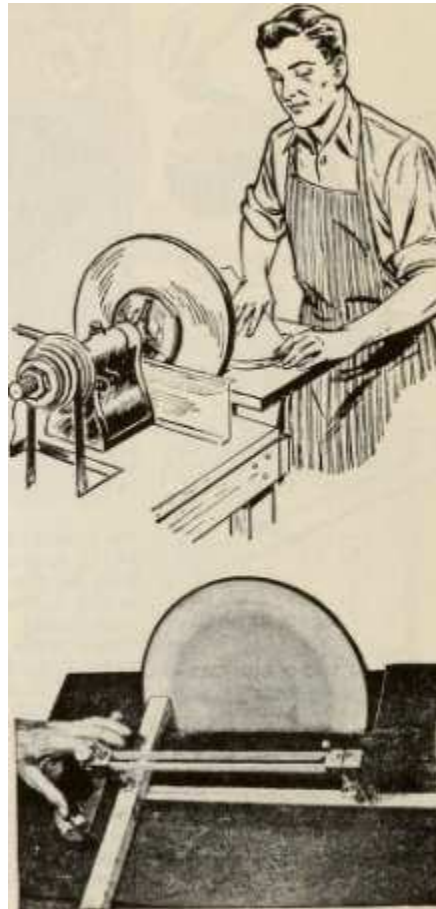
from lathe headstock

FOR SQUARING small pieces of wood, rounding corners and sanding end grain, you can't beat a large disk sander. The driving head of the sander pictured was adapted from an old

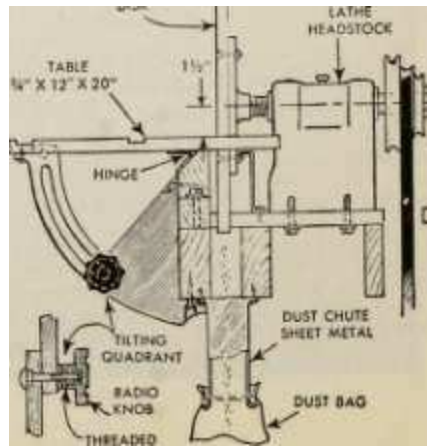
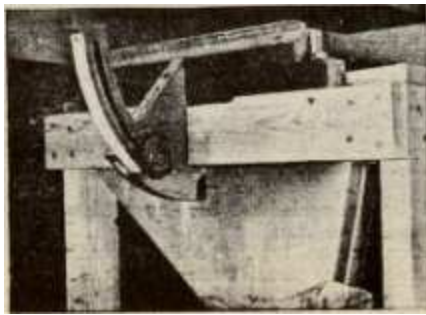
wood-lathe headstock, but a grinding head or a small ball-bearing saw arbor can be utilized for the same purpose. In any case, the driving head must be fitted with a faceplate to which the sanding disk can be attached and detached readily when it is necessary to change the abrasive disks. In some instances, a ready-made disk with either a plain or threaded hub to fit the spindle can be utilized. Complete dimensions in the lower detail at the right are not given, as it is necessary to provide a suitable table mounting, and this will depend on the diameter of the disk and on the type of driving head used. For all-around use, the disk should be 10 or 12 in. in diameter and the table should be fitted with trunnions which permit it to be tilted. The table should be made of plywood, or solid hardwood, and grooved so that a miter gauge can be used to sand the end grain on stock cut to compound angles. Provide a dust chute and bag, as shown, and attach the table trunnions to the machine base, or bench, so the table can be removed when changing the abrasive disks.

Calibrated scale glued to edge of slotted quadrant to

permits accurate setting of table from 0 to 45 deg. 12"X20" Plywood table is hinged to beveled edge of support with a length of piano hinge to provide a rigid mount



12" SANDING DISK



DUST BAG

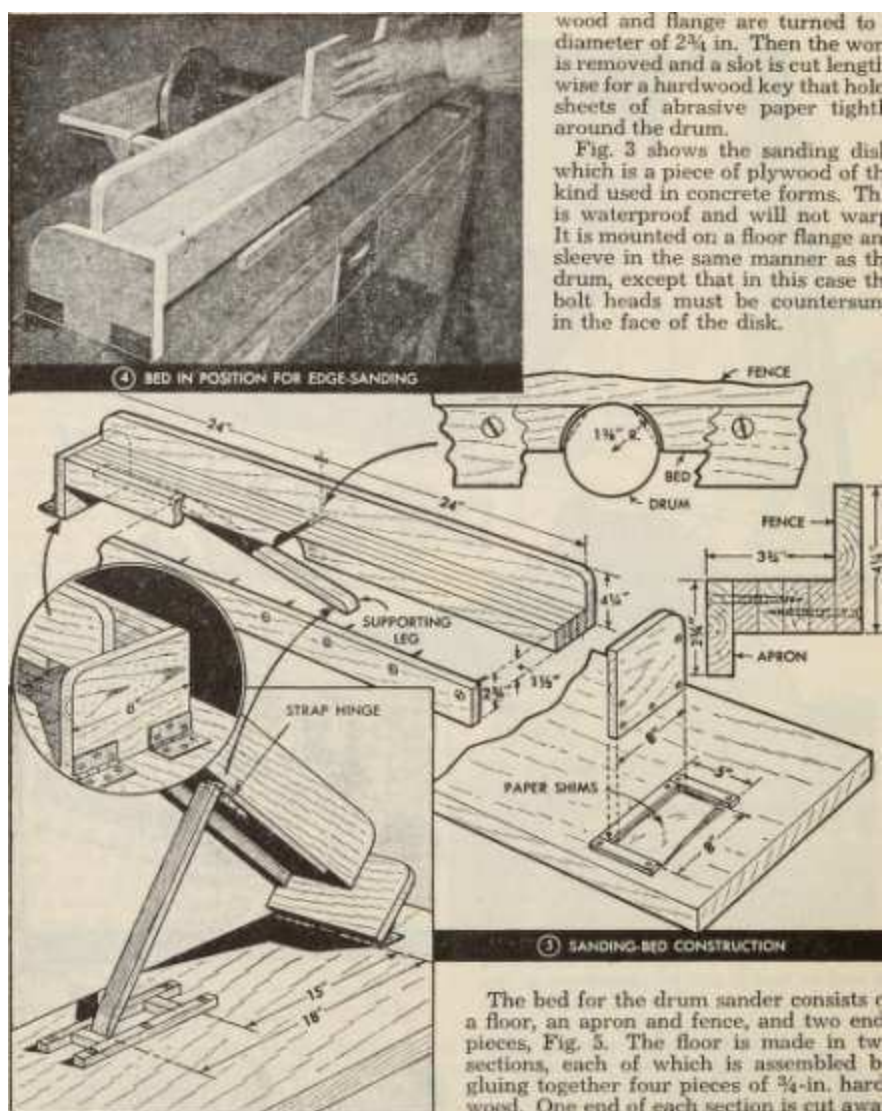


If WITH a $\frac{1}{4}$ -hp. or larger electric motor
 f having a double-end shaft, and some
 Ip wood, you can make this combination
 inn-and-disk sander, which will serve for
 ixlost all ordinary sanding operations in
 'e small woodworking shop. The motor
 s mounted on a sturdy bench or table. A
 f orizontal bed is used to feed the work
 ^ver the drum sander in the manner of a

winter, as in Fig. 4. The bed is hinged at the end so that it can be raised out of the way as in Fig. 1, when sanding inside curves and work of irregular shape. Also, it is an adjustable disk-sanding table, and can be tilted for sanding work at various angles, Fig. 8, or it can be set horizontally for accurate, 90-deg. corners, as in Fig. 9.

The drum is made by assembling four pieces of 1/2-in. hardwood of suitable size on a floor flange, gluing the pieces of wood and clamping them tightly with stove bolts, Fig. 2, which hold the assembly together. When the glue is dry, a pipe, nipple is screwed into the flange. The nipple should

(3) HOW DISK IS ASSEMBLED



wood and flange are turned to a diameter of $2\frac{3}{4}$ in. Then the work is removed and a slot is cut lengthwise for a hardwood key that holds sheets of abrasive paper tightly around the drum.

Fig. 3 shows the sanding disk, which is a piece of plywood of the kind used in concrete forms. This is waterproof and will not warp. It is mounted on a floor flange and sleeve in the same manner as the drum, except that in this case the bolt heads must be countersunk in the face of the disk.

o SUPPORTING LEG AND RACK

fit on the motor shaft snugly and reaming may be necessary. Or you can make up a sleeve from solid stock, drilling it to shaft size and threading one end to fit the flange. Then the nipple is drilled and tapped and the flange is slotted as shown to take a set-screw that locks the nipple and flange to the motor shaft. Now, the assembly is mounted in a lathe with a face plate and dog, so that the center line through the nipple is in line with the lathe center. Both

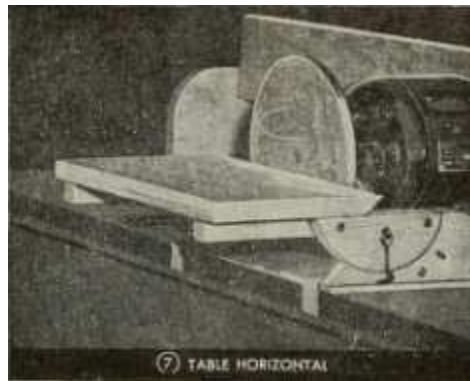
(J) SANDING-BED CONSTRUCTION

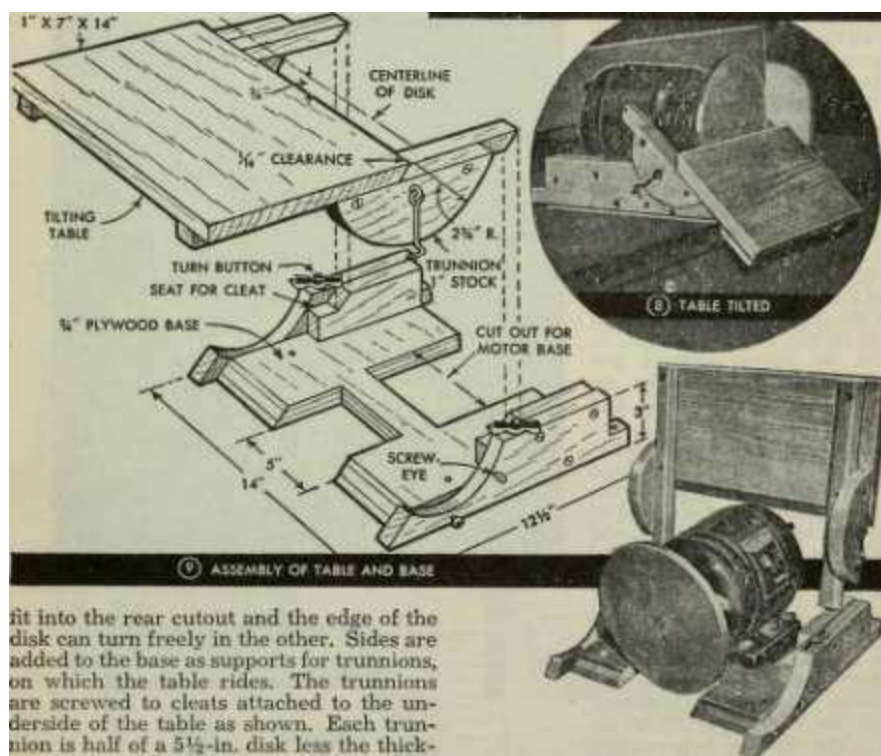
The bed for the drum sander consists of a floor, an apron and fence, and two end-pieces, Fig. 5. The floor is made in two sections, each of which is assembled by gluing together four pieces of $\frac{1}{2}$ -in. hardwood. One end of each section is cut away at an angle and then is sanded on the drum so that when the sections are assembled there will be a concave cutout of $1\frac{1}{2}$ -in. radius over the drum as shown in the upper detail of Fig. 5. The apron and fence are screwed to the floor sections as in the right-hand detail, the screws also serving to supplement the glue in holding the floor strips together. The floor of the bed must be flush with the top of the drum without a covering of abrasive paper. Next, the endpieces of the bed are screwed in place, with their upper edge flush with the bed floor. One

of the endpieces is hinged to the work table; the other is held in a stabilizing frame consisting of three cleats. Paper shims are placed in the frame to regulate the height of the bed above the drum to accommodate varying thicknesses of abrasive and to permit sanding work to desired depths. When the bed is raised, it is supported by a leg set in a rack as in Fig. 6.

The disk-sanding unit, consisting of table and base, is shown in Fig. 9. The base can be made of $\frac{1}{2}$ -in. plywood or other suitable stock, cut in the form of the letter H, so that the motor base will

7'X7"X 14"



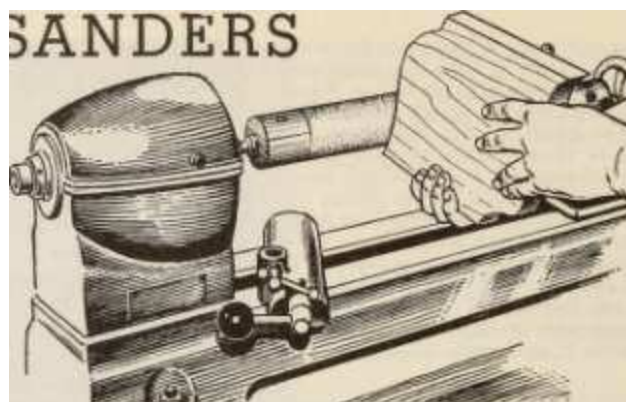


fit into the rear cutout and the edge of the disk can turn freely in the other. Sides are added to the base as supports for trunnions, on which the table rides. The trunnions are screwed to cleats attached to the underside of the table as shown. Each trunnion is half of a 5 1/2-in. disk less the thick-

fit into the rear cutout and the edge of the disk can turn freely in the other. Sides are added to the base as supports for trunnions, on which the table rides. The trunnions are screwed to cleats attached to the underside of the table as shown. Each trunnion is half of a 5 1/2-in. disk less the thickness of the table. The upper surface of the table, when horizontal, should be 1/8 in. below the center of the sanding disk, and there should be a clearance of 1/16 in. between the table edge and the sanding disk when abrasive paper is attached. With the table in the horizontal position, the cleats rest on supporting pieces screwed to the sides of the base, and are held by turn buttons. A screen-door hook on each trunnion is slipped over screws driven part way into the sides. These also help to hold the table firmly in the horizontal position. To hold

the table in a 45-deg. position, as in Fig. 8, the hooks engage screw eyes located in the base. Screws and screw eyes should be positioned so that considerable pressure is required to release the hooks in order to prevent play, which otherwise may be considerable.

With a drum and disk of the sizes given here, you can use one 9 by 11-in. sheet of abrasive to cover both; an 8-in. disk and a 3 by 9-in. piece to fit the drum, leaving a 1 by 8-in. strip.



COUNTERSUNK FOR BOLT

LATHE SANDERS

DO YOU need disk ^-^ and drum sanders to supplement your belt Sander? They can be obtained inexpensively by simply turning a wooden drum to operate between your lathe centers, and a plywood disk to attach to the lathe faceplate or screw center. For the disk sander, you will need a simple table to fit on the lathe ways as in Fig. 3. To make the drum sander, select two pieces of hardwood, one piece

1 in. thick and 3 in. wide, the other

2 in. thick and 3 in. wide. The drum can be any convenient length up to about 15 in. If it is made longer without increasing the diameter proportionately, there is a danger of whipping at high speeds. Glue the pieces together, as in Fig. 1, with a sheet of heavy paper between them. When the glue is dry, mark the center on each end; then mount in the lathe and turn to 2½ in. in diameter. Drill and counterbore each part near the ends for a ¼-in. stove bolt, and then separate the pieces by running a sharp knife blade along the joint. A piece of 1-in. cloth tape attached to one side of the drum over the joint makes a durable, continuous hinge. Cover the drum between the bolt holes with ½-in. felt, the edges of the felt meeting at the joint. Glue only the ends of the felt to the two parts of the drum, as in the lower detail. Fig. 1. When the hinged parts are drawn together with the bolts, the felt should be tight. Wrap sandpaper around the drum and insert its ends in the opening between the hinged parts. Then tighten the bolts. For best results, the drum should operate at a speed of about 2000 r.p.m. with a medium-grit sandpaper. Fig. 2 shows another way of operating the same type of

drum with an improvised tailstock, driving it with either a polishing head or a small grinder having a threaded spindle on which a drill chuck can be mounted. A driving flange is made by inserting a pin tightly in

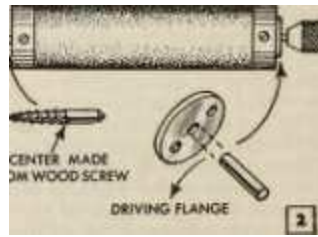
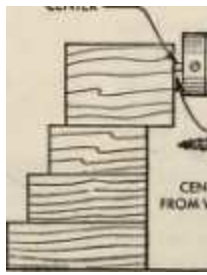
TURNED TO 2½" DIA.

ENDS OF . SANDPAPER PRESSED INTO OPENING ,

CLOTH TAPE FORMS HINGE

FELT GLUED AT ENDS ONLY

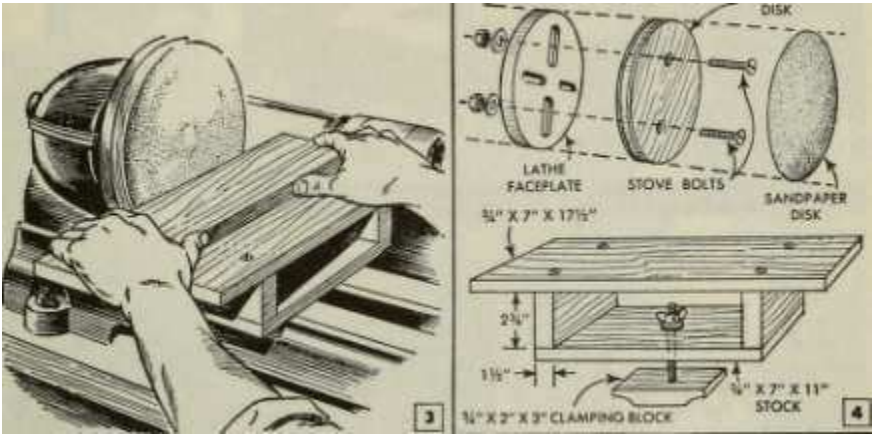
CENTER



CENTER MADE FROM WOOD SCREW

DRIVING FLANGE

a small disk cut from $\frac{1}{8}$ -in. sheet metal. Fig. 2. The disk is screwed to the drum end. Figs. 3 and 4 show how to make the sanding disk and a table which clamps to the lathe bed. When in position on the lathe



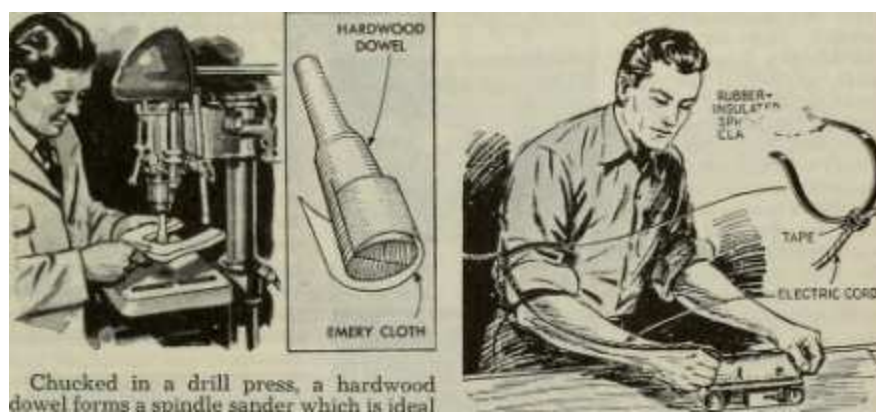
$\frac{1}{8}$ " X 8" PLYWOOD DISK

bed, the top of the table should be about $\frac{1}{8}$ in. below the center of the disk. This distance is determined by the swing of

Dowel Chucked in Drill Press Serves as Spindle Sander

your lathe. For average small work, a disk speed of 2000 r.p.m. is recommended by experienced craftsmen.

Spring Clamp HoMs Sander Cord Out of Operator's Way



Chucked in a drill press, a hardwood dowel forms a spindle sander which is ideal for quickly smoothing the edges of intricate scrollwork. One end of the dowel is tapered to fit the drill-press chuck and the other end is slotted. Then a 1-in.-wide strip of emery cloth is inserted in the slot and torn off so that it completely encircles the dowel. If the cloth is mounted as shown in the detail, it is not necessary to glue it, as the clockwise rotation of the drill press will hold it in place.

To keep the electric cord out of the way when operating his portable electric sander, a carpenter uses a spring clamp, which holds the cord to his arm. The clamp is insulated with a covering of rubber tubing.



SANDING BELTS

You can buy cloth-backed abrasive in 10 to 50-yd. rolls and make your own sanding belts at a considerable saving in cost. By making your own you can use special grits and abrasives as needed. Start by taking the length from an old belt, allowing for the joint, as in Fig. 1. Next, remove the abrasive from each end of the belt by rough sanding, as in Fig.

3, with a coarse, silicon-carbide stone—the kind used for dressing grinding wheels. Then dampen the joint with water. Fig.

4. Let it stand a few seconds to soften the adhesive, and scrape with a knife as in Fig. 5. If

the belt has a light cloth backing, make the joint by dry sanding only, in order to avoid puckering the cloth. Line the joint

1/8" FOR BELTS 8" TO 20" LONG, FOR BELTS OVER 20' LONG AND WIDER THAN 3'



up over a backing board having a straight edge. Fig. 2, and nail to prevent shifting. Slip a sheet of newspaper under the joint, apply glue, and then clamp as showTi in Fig. 7. Use hot glue or casein. Avoid quick-drying flexible cements and most other cold glues as they dry stiff or lack strength. Fig. 6 gives average joint dimensions. The double skive (abrasive removed from both ends of belt) is recommended for all belts except 50-grit or coarser. These roughing belts can be made with single skive (abrasive removed froni one end only) since a smooth-running joint is not essential.

SANDING TIPS



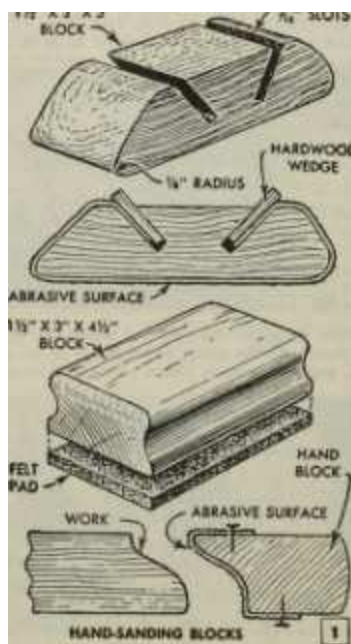
Photos and technical service courtesy

The step between the last tool work and the finishing coat is often the difference between is professional-appearing job and a project hallmarked "amateur"

SANDING the surface is one of the most important operations preparatory to finishing home-workshop projects built of wood. This must be done to remove hand-tool or machine-tool marks and also to smooth the surface of the wood so that reflective properties of the finishing materials are equalized to bring out the full beauty of the wood grain. By taking time to do a good job of sanding, using correct procedures and selected grades of abrasives, you can expect a finish of professional appearance and quality. In small home shops with limited equipment, sanding must be done entirely by hand, making selection of the abrasive and the manner of using it the most important steps in the finishing procedure. For sanding by hand on bare (unfinished) wood, there are four sandpaper grades, or grits in common use. Fig. 7 classifies these in sizes ranging from coarse to very fine. The table, Fig. 7, also gives the grit numbers by which

1"x3"x5" BLOCK -v^

J<»" SLOTS



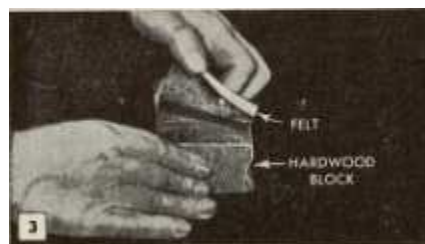
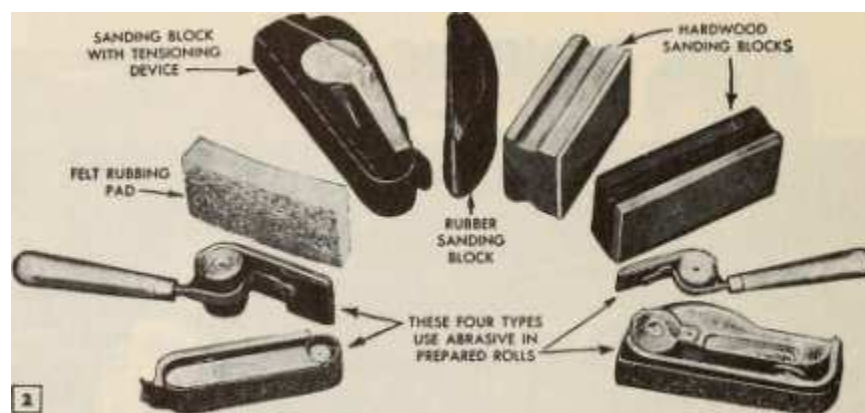
HAND-SANDING BLOCKS

SANDING BLOCK

WITH TENSIONING

DEVICE

HARDWOOD SANDING BLOCKS



A hardwood block fitted with a felt backing makes a very efficient hand-sanding tool. Felt backing is glued in place and can be from 1/8 in. to 1/4 in. thick.

The all-rubber sanding block pictured above is especially useful for general handwork because it is flexible. Various types designed for abrasives in prepared rolls are handy for

sanding corners and edges

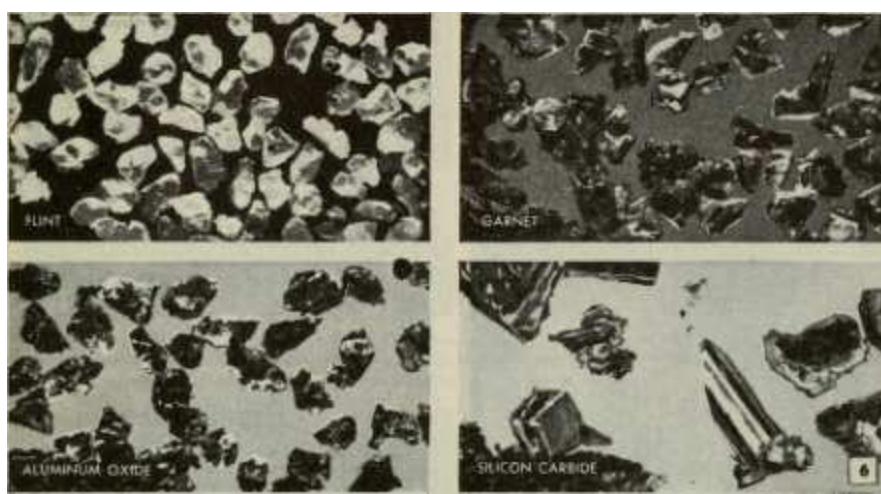
these abrasives are commonly known. There also is a very coarse grade for special purposes, but this is not generally used in hand sanding because of the difficulty of removing the surface scratches with finer grades of sandpaper. Although it is still available and is listed in Fig. 7 and pictured in Fig. 6, the flint paper has been largely replaced by the faster cutting garnet and aluminum-oxide abrasives for use in hand sanding. Most of the abrasives used in handwork are paper-backed and usually are designated as A, C, D and E. The first, or A grade, is known as "finishing paper." The C and D grades are referred to as "cabinet paper" and the E grade as "roll stock." The latter is heavyweight with a stiff paper backing and is only occasionally used in handwork. The A grade is light and flexible and in the coarser grits is used for light smoothing on paint and other finish coatings. The C and D weights have a heavier and less flexible paper backing and are most commonly used on bare wood. A general classification and recommendation for grades of paper to be used on various types of work is given in Fig. 10.

To obtain a smooth and uniform action with any of these sandpapers on flat surfaces, the paper must be backed with a hand-fitting block made either of wood or metal. Two excellent types of hand-sanding blocks are shown in the three upper details in Fig. 1. One block has no felt pad and is especially suited to cutting down ridges and other irregularities on wide widths of stock. The rigid backing causes the abrasive to cut very fast with a leveling action on the whole area being sanded. The second block, also shown in Figs. 2 and 3, is fitted with a felt pad and is suitable for rough-sanding the stock at an angle with



Above, except on open-grained woods, finish-sanding is done with the grain. Below, sand at an angle to the grain to remove ridges and other irregularities





Greatly enlarged photos show the variations in the grain characteristics of the more commonly used abrasives. Although it is still available, flint is being largely replaced by the garnet and aluminum oxide

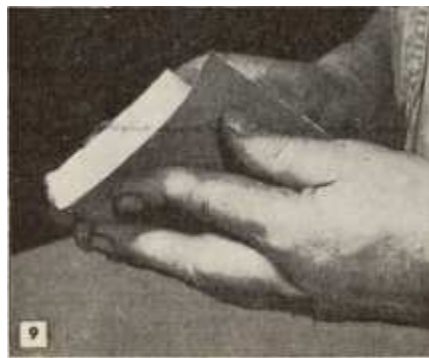
the grain as in Fig. 5, and for finish-sanding with the grain as in Fig. 4. All the various types of hand-sanding blocks and pads shown in Fig. 2 are readily available. Four of these are designed for prepared cloth-backed rolls in narrow widths and are especially handy for working in corners, on rounded edges and on wide moldings. The rubber sanding block pictured is just the thing for sanding flat surfaces and it also works particularly well on curves of long radius. Owing to its flexibility, it readily conforms to the curve of the surface. Of course, the ordinary wooden block, fitted with a thick felt pad glued on as in Fig. 3, is equally effective for surface-sanding large work, but the sandpaper must be held in place with the thumb and fingers, as in Figs. 4 and 5. All the ready-made blocks are provided with a means of holding the sandpaper securely in place.

Before starting a sanding job it's a good idea to have on hand a supply of the grades of sandpaper ranging from coarse to very fine. For average work, a good selection includes No. 1 coarse garnet or aluminum oxide, 2/0 medium, 4/0 fine and 6/0 or 8/0 very fine. A typical example of hand-sanding procedure in the home shop would be that used on a small table top similar to that pictured

in Figs. 4 and 5. Usually the top has been built up by gluing together several narrow strips. There will be slight ridges at the glue joints which must be leveled and the wood sanded down to a glass-smooth surface. Begin sanding with No. 1 coarse paper at an angle with the grain as in Fig. 5. This step will level the ridges and remove the glue stains and other discolorations. Continue sanding with the coarse paper until the surface has been leveled. The coarse abrasive will leave fine scratches over the entire surface at an angle with the grain. Now, discard the coarse abrasive and follow with the medium grit, either 1/0 or 2/0, and sand with the grain as in Fig. 4. If the top is made from a coarse, open-grained wood such as chestnut or red oak, sand at a

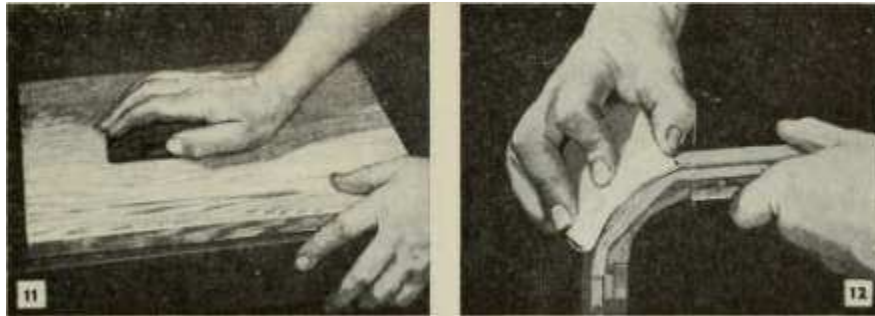


Above, abrasives rather than scrapers are now commonly used in preparing old work for refinishing. Below, on some types of work a felt backing is used



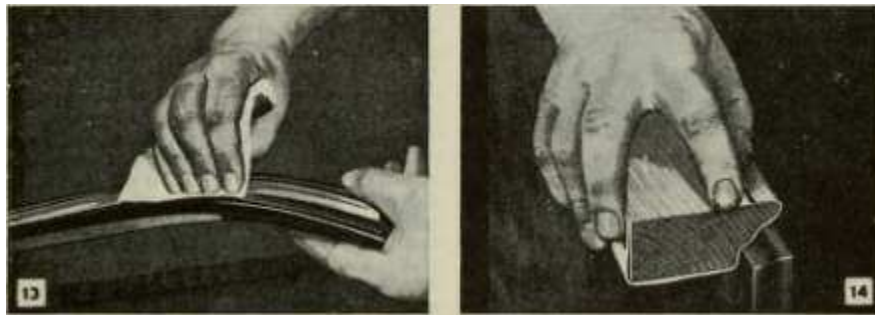
slight angle to the grain to avoid enlarging the individual pores of the wood by rounding the edges. This should be kept in mind when hand-sanding all open-grained woods, as individual grains of the abrasive passing through the tiny elongated pores parallel to their length tend to enlarge them. This leaves the surface rough and, in some cases, even changes the pattern of the grain to some extent. The second step should be continued until all fine scratches produced by the first sanding have been eliminated. Next, change to the fine grade of paper, about 4/0 grit, and sand directly with the grain, Fig. 11. At this stage, the surface will be approaching a degree of smoothness capable of reflecting oblique light. Hold the work horizontally at a point just below eye level and look across it toward a light source. Any minor ridges or other irregularities will show up quite clearly and can be pencil-marked on the outlines of the high points and then sanded down with the fine abrasive until the reflection of light is uniform over the whole surface. Before the final sanding with very fine finishing paper, some experienced craftsmen prefer to apply a thin wash of shellac or sanding sealer. Some finishers also dampen the wood with a sponge to raise the grain. After drying, the raised grain is sanded smooth and either sealed or shellacked with a very light wash coat before proceeding to the final sanding. The latter is done with either the 6/0 or 8/0 paper, depending on the degree of smoothness

required. When working with open-grained woods that require staining and filling many finishers apply stain and filler, allow to dry and then finish-sand the surface. In this procedure it will be necessary to apply a few drops of rubbing oil to the sandpaper occasionally to prevent clogging. Care must be used in this method to avoid cutting through the stain and exposing bare wood. Succeeding applications of the finishing materials are sanded lightly between coats. Essentially the same procedure is used when refinishing old work which has been varnished or painted, Fig. 8. After removing the old finish to the bare wood, begin with the coarse abrasive to remove discoloration and surface irregularities, then follow with the finer grits in the same sequence as on new wood. On some types of both old and new work, the abrasive can be advantageously used with only a thick felt backing, Figs. 9, 12 and 13. Note in Fig. 13 that the craftsman is sanding a curved molding with the four fingers



When finish-sanding with very fine paper, make the stroke directly with the grain of the wood. Apply uniform pressure the full length of the sanding stroke

When sanding short-radius curves, the flexibility of the thick felt pad allows the abrasive paper to conform to the curved surface across its full width



By backing the sandpaper with a thin felt pad you can sand curved moldings preparatory to refinishing. Note position of fingers to maintain uniform pressure

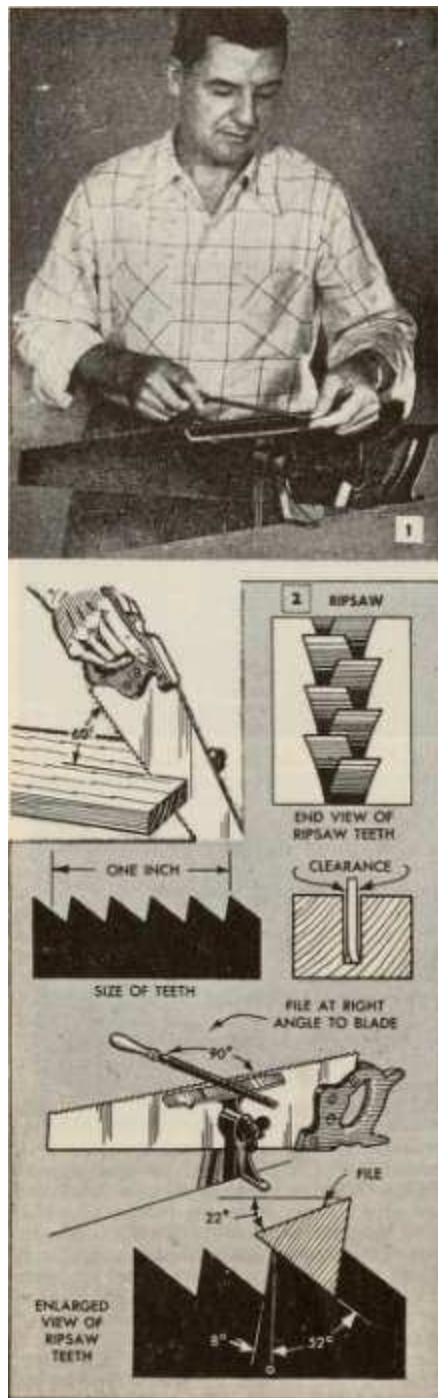
A sanding block with one edge shaped in a reverse relief of the molded edge makes it possible to remove old varnish or enamel from the mold curves

of his right hand held directly in line to equalize the pressure on the concave surface. Fig. 12 pictures another practical application of the flexible felt pad on a built-up corner having a short-radius curve. On old work it often is necessary to sand molded shapes. This is quite easily done by making a special wooden block with one edge shaped in reverse

relief so that it conforms to the molded shape, Fig. 1. Usually this can be done with hand tools, such as inside and outside gouges and, if care is used to bring the shape to exact reverse relief, sandpaper wrapped around the block as in Fig. 14 will clean up a molded edge as good as new.

The trick in producing a true, flat surface by hand sanding is to adopt a sanding stroke of uniform length and equalized pressure. If you stroke the sandpaper as far as you can reach in both directions on a large surface, the pressure will fall off near the end of the individual stroke, resulting in an uneven surface. Some experienced finishers sand with short, straight strokes and, by moving back and forth ^along the length of the work being sanded,

the strokes are made to overlap continually. This technique produces a true, flat surface on large work, such as a table top. When sanding to an edge, the sanding block should not be allowed to extend beyond the edge more than one fourth its length on each stroke as, otherwise, a rounded edge will result. Whether sanding large or small work, the strokes should overlap about half the width of the sanding block and should progress uniformly in one direction at right angles to the direction of the stroke. On old work where it is desired merely to smooth the old finish preparatory to varnishing or enameling, finishers generally use a fine waterproof ("Wetordry") sandpaper, applying water or rubbing oil as a lubricant and also to prevent the paper from clogging with loosened particles of the old finish. In some cases, open-coated abrasives are used when hand sanding on enameled surfaces preparatory to resurfacing. The open-coated papers have the abrasive grains widely spaced to prevent clogging and also to make the abrasive cut faster on rough work where scratches will later be removed by finer sandings.



SAW FILING

Filing a handsaw is easy to do if you follow a simple step-by-step procedure recommended by experienced craftsmen

OHARP HANDSAWS cut true and fast ^ and enable the user to turn out finished work of an accuracy and quality very nearly equal to that produced on power-driven machines. Common handsaws are of two types, one being designed for ripping stock lengthwise with the grain and the other for cutting across the grain or at an angle to it. Backsaws, dovetail saws, keyhole saws and others are simply variations of the crosscut handsaw designed for a specific purpose. On the ripping saw, each tooth cuts like a chisel, severing only the wood fibers which are directly in the path of the tooth as it is forced through the wood. Teeth of a crosscut saw cut the wood fibers at right angles to the direction of travel and

for this reason they must be sharpened in such a way as to give each tooth two cutting edges or, more specifically, a leading cutting edge and a sharp, cutting point. This double-cutting edge is produced by merely changing the angle of the file.

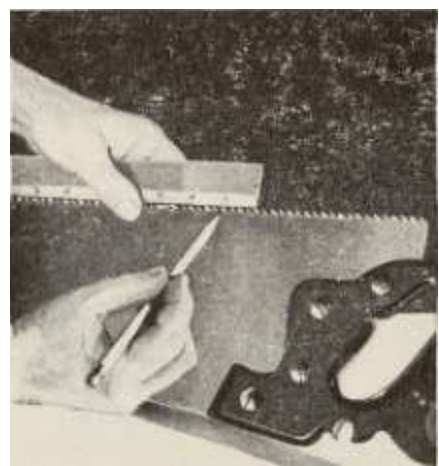
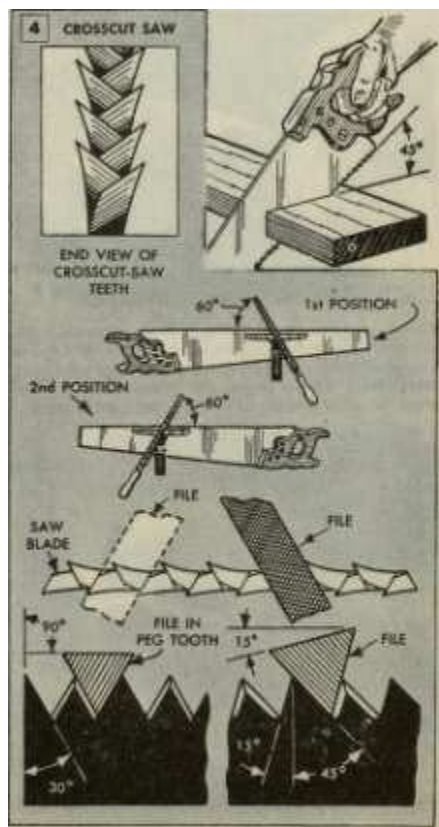
Jointing: Before any handsaw can be properly filed it is necessary that the teeth be made uniform in height. This operation is known to saw filers as jointing and it is done by passing a file over the points of the teeth in one direction as in Fig. 3. Steady the file with a small block of wood, as shown, to prevent it from tipping sidewise and rounding the points. After the first few light strokes of the file it will be seen that some of the tooth points have been flattened on the top while others have been only slightly tipped by the file. Continue the jointing until all flattened points can be seen clearly. The amount of jointing necessary must be judged by the condition of the saw. If the saw has been properly filed and the teeth are regular in shape and uniform in height, jointing may be unnecessary. On a saw in this condition only light filing will be required. On the other hand, if the teeth are uneven and incorrectly shaped, it may be necessary to reshape the teeth by jointing and filing several times at short intervals during periods of use. As a rule, it is best to joint the teeth lightly each time the saw is filed.

Setting: Some experienced saw filers prefer to set the teeth of handsaws before jointing. Others joint the teeth lightly both

before and after setting, especially when sharpening ripaws. The reason for this is shown in Fig. 2. Note in the detail that the leading edges of the teeth are parallel, one with another. As in jointing, the necessity of setting and also the amount of the set is determined by the condition of the saw and the nature of the work which is to be done with it. For example, a ripaw used exclusively on hardwood requires less set than one which is used only on softwood, or on soft and hardwood alternately. In general, the same is true of the crosscut saw, but the width of the set will vary owing to the variations in the number of teeth per inch, and also to the purpose for which the saw is intended. Setting tools of the type shown in Fig. 6 are commonly used on handsaws. The purpose of the set is to cause the teeth to make a cut slightly wider than the thickness, or gauge, of the blade. This gives clearance and prevents friction and binding of the blade between the cut edges of the wood. In relation to the length of the tooth, the depth of the set should never be greater than half the length of the tooth measured from the point to the bottom of the space, or gullet, between alternate teeth. A deeper set may break the tooth. Saw sets of the type shown in Fig. 6 have fine adjustments for regulating the depth and width of the set on handsaws with a varying number of teeth per inch. Be sure that the setting tool is correctly adjusted to give the depth and width of set required. Begin at the heel of the blade (the end next to the handle) and place the setting tool on the first tooth bent away from you. Then, after setting the first tooth, skip one and place the setting tool on the next tooth bent away from you. Proceed in this manner to set the teeth, along the full length of the blade. Then turn the blade end for end and repeat the procedure. The trick in obtaining a uniform set is to apply equal pressure to the handles of the setter for each tooth. Filing crosscut saw: Because of the variety of saw-tooth shapes, the variation in angles and bevels and the number of teeth per inch on crosscut saws designed for different purposes, a careful selection of the file is necessary as the size and type of the file determines the tooth shape. On crosscut handsaws having four, five and six points to the inch, use a 7-in. three-cornered (triangular) file of the type known as "slim taper." Use a 6-in. slim-taper file on saws having seven and eight points to the inch; and on handsaws having fine teeth running nine to twelve points to the inch, use a 5-in. file. To determine the number of teeth to



Before filing, the teeth of a handsaw are jointed with a file so that all of them are the same height

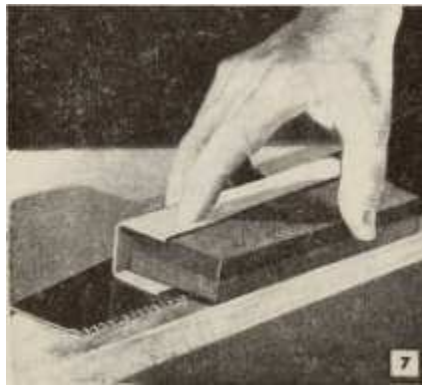


To determine the number of teeth per inch, measure 1 in. from the point of any given

tooth with a ruler and count number of teeth within the 1-in. distance



Above, on both crosscut and rip saws adjacent teeth are set, or bent, in opposite directions to give clearance for the blade. Below, as a finishing operation after filing, the teeth are side jointed with an oilstone to align points and make saw cut smoothly



the inch, measure 1 in. from the point of any tooth and count the number of teeth within the 1-in. distance, as in the left-hand center detail in Fig. 2, and also Fig. 5.

Place the saw in a filing vise of the type shown in Fig. 1, with the handle at the left as in the first position shown in Fig. 4. (A suitable vise can be improvised from C-clamps and two strips of hardwood.) The vise jaws should close on the blade at a point about $\frac{1}{8}$ in. below the bottom of the spaces between the teeth. The tip of the blade should not extend beyond the end of the vise jaws at the first setting. Begin filing by noting the first tooth at the tip that is set, or bent, away from you. Place the file in the space to the left of this tooth and then swing the file to the right so that its angle with the blade is approximately 60 deg. Hold the file level at this angle and make the first stroke. Lift the file at the end of the stroke, return it to the original position and place it in the same space, or gullet. Make the second stroke in the same way. At this point it is important to allow the file to find its own bearing against the teeth. Do not twist the file or maintain any pressure on it except that necessary to move it on the forward stroke against the resistance of the metal being cut. Note also that the file is cutting on one face of two adjacent teeth, the points of which have been flattened by the jointing operation. The trick is to adopt at this point a uniform stroke of the file that will remove only half of the flattened portion of the tips of adjacent teeth. On saws that are in good condition with teeth of nearly uniform length, it also is necessary to use an equal number of file strokes per tooth. The exception to this is on saws having teeth in poor condition where the flattened points of adjacent teeth vary, making it necessary to reshape the teeth, at least partially, as filing progresses. Continue

filing to the end of the blade, skipping a space, or gullet, after filing adjacent teeth and placing the file in the gullet to the left of the next tooth bent away from you. When one side has been finished, turn the blade end for end and proceed as before. Filing the blade from this side should bring each tooth to a sharp point. The operation on each tooth should be carefully watched to avoid the possibility of removing too much metal and getting the teeth on one side shorter than those on the other. Be sure to hold the file level and keep the length of the stroke uniform. At this stage, many filers joint the teeth lightly and again touch them up to assure perfect uniformity in length and sharpness. However, this is rarely necessary unless the teeth were in bad condition before filing. It also should be noted that some experienced filers begin filing with

the blade placed in the reverse position from that given in the center details in Fig. 4, that is, the handle is placed first at the filer's right, instead of his left, as shown. Some manufacturers recommend this position, and filers who prefer this method say that it is easier to maintain a uniform stroke of the file. In this case, start filing at the heel of the blade, placing the file in the space to the left of the first tooth bent toward you.

Filing rip saw: In general, the procedure in jointing, setting and filing a rip saw is the same as that used in sharpening a crosscut saw except that the file stroke is made straight across with the file held level and exactly at right angles with the blade. This position of the file points the teeth with parallel chisel edges. The file is tilted with its top face at an angle of 22 deg. as shown in the lower detail, Fig. 2. This position of the file gives the leading edge of each tooth a negative rake of approximately 8 deg., which is commonly accepted practice

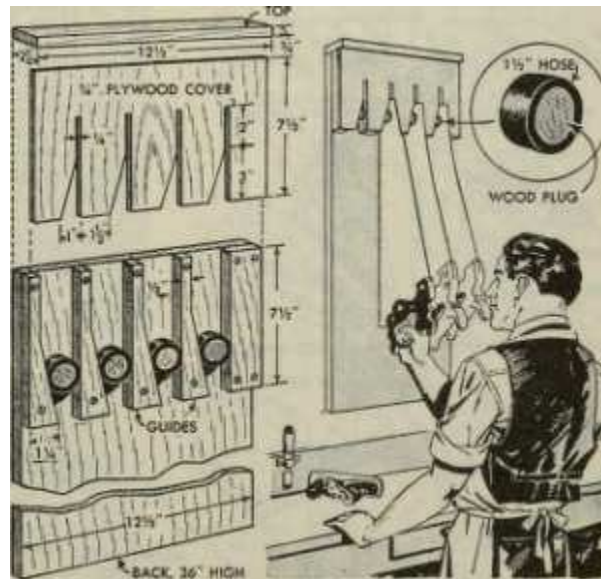
on hand rip saws used for average work. Some carpenters like a rip saw with plenty of "bite" and to accomplish this they reduce the negative rake from 8 to 5 deg. or even less. This angle of the teeth makes the rip saw really take hold, but it is more difficult to control in softwood and is not suitable for use in hardwood. With the teeth filed as in the lower detail, Fig. 2, the rip saw will cut smoothly in either hard or softwood. It is easily controlled for close following of gauge lines and requires less pressure on the downward stroke.

As a final operation when sharpening both crosscut and rip saws for fine work where the sawed edges must be left smooth, filers side joint the teeth with an oilstone as in Fig. 7. This operation dresses the points of the teeth to exact alignment. Use the fine side of the oilstone and wrap cloth or cardboard around one side of the stone to protect the blade from scratches. Two or three light strokes of the stone on each side of the blade usually are sufficient.

SAW RACK

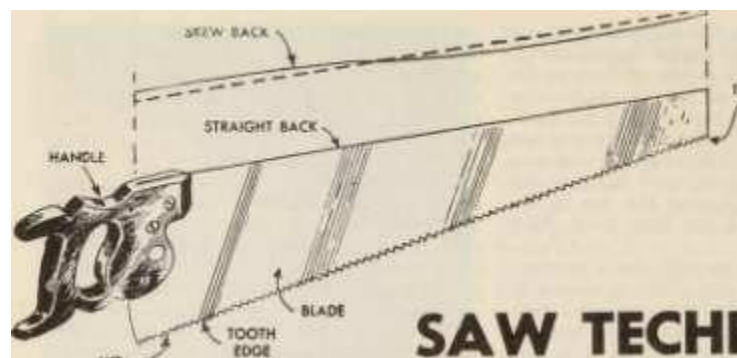
^Rubber-Tired' Rollers Hold Saws in This Rack

After trying several different types of handsaw racks, we found the one illustrated to be the most convenient. When hung within easy reach over the workbench, it is nearly as easy to replace the saw in the rack after each cut as it would be to lay it on the bench. While holding the saw by the handle in a natural position, you simply push the end up into the slot where a rubber-covered roller grips it firmly. A saw is removed by a slight upward and outward motion. The rack can be made to accommodate as many saws as desired, and consists of a plywood back to which are screwed guides shaped as shown. You'll need one guide for each saw. Rollers housed between the guides are held in place by a plywood cover slotted at the lower edge as indicated. The rollers are slices cut from large hose and fitted with wood plugs or cores. When a saw is inserted, the rollers rise slightly to



let it pass, but when the saw is released, its weight causes the roller to press it tightly against the back of the adjoining guide and thus hold it securely in place.

AKEW BACK

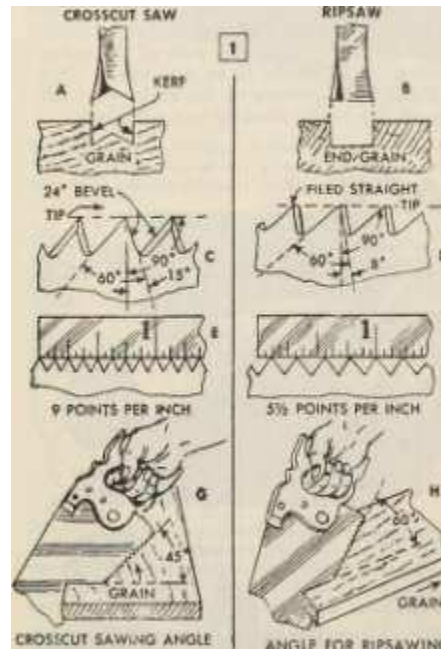


TOE OR TIP

He6i

SAW TECHNIQUES

CROSSCUT SAW



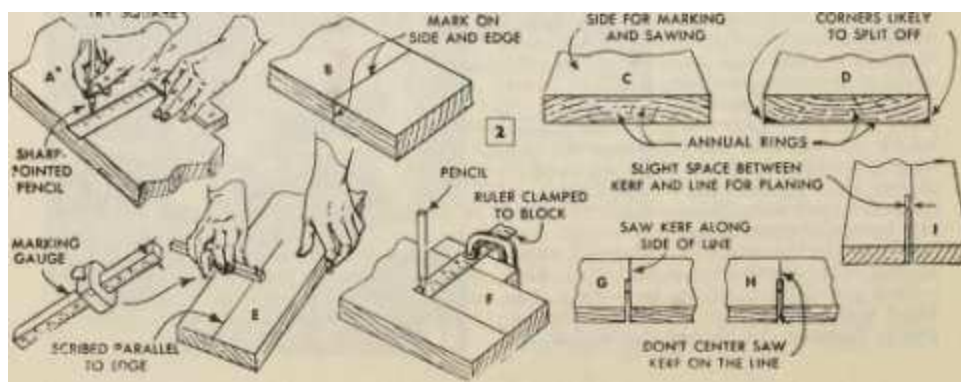
CROSSCUT SAWING ANGLE TRY 5Q'JASE

GRAIN ANGLE FOR RIPSAWING

THERE'S NOTHING difficult about saw-^{*}ing straight, but it's more than just pushing a saw back and forth. Accurate sawing depends on: (1) having a good sharp saw that is filed and set correctly; (2) using the right saw for the job; (3) applying the proper technique. Quality saws have taper-ground blades that are thinner at the back than at the toothed edge. This makes sawing easier and minimizes binding of the blade in the cut or kerf. Most homeowners first acquire a 20-in. 10-point crosscut saw, then add a 26-in. 5y2-point rip saw and a compass or keyhole saw.

How crosscut and rip saws differ: While they are interchangeable for short cuts, crosscut saws should be used for cutting across the grain in wood and rip saws for sawing with the grain. The teeth of a crosscut saw are shaped like sharp-pointed knives and cut on both the forward and back stroke, making two parallel cuts. Fig. 1-A. The edges of the teeth are beveled at 24 deg. Rip saw teeth have edges filed straight across to cut flat-bottom kerfs like

CORNERS LIKELY TO SPLIT OFF

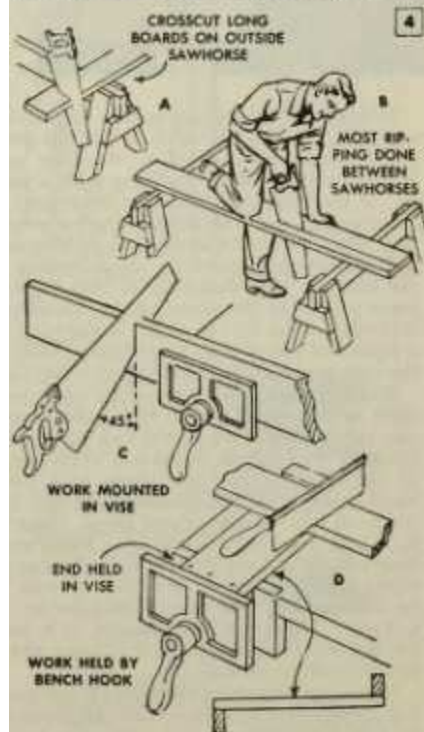


If using a handsaw is just plain hard work and the results are never as good as you expect them to be, here are some things you will want to know. Sawing can be done easily and accurately by following a few pointers of handsaw know-how

tiny chisels, detail B, and cutting is done only on the forward stroke. Teeth of both crosscut and rip saws have an included angle of 60 deg., but the front cutting edges of the teeth of crosscut saws are filed at a 15-deg. angle, as in detail C, whereas the front edges of rip saw teeth have an angle of only 8 deg., detail D. Teeth points must be of equal height. The upper half of each tooth is bent outward or "set" in the direction of its flat side. Thus alternate teeth are set in opposite directions. The set determines the width of the kerf and, being greater than the thickness of the blade, allows it to move through the kerf easily.

The number of tooth points of crosscut saws varies from 7 to 12 points per in., detail E, while points of rip saws number 5V2 per in., detail F. Coarse-tooth crosscut saws cut faster but leave a rougher surface than fine-tooth saws. A coarse saw is best for cutting green or wet wood, while a fine one is best for dry, seasoned lumber. Crosscut blades are regularly 20, 22, 24 and 26 in. long, although smaller ones are available. Those shorter than 24 in. are called panel saws. Rip saws usually come in 26-in. lengths. The tooth edge of a crosscut saw should be held at a 45-deg. angle to the work surface, as in G. The best angle for ripping is about 60 deg., detail H, but on thin stock a 45-deg. angle is preferable.

Accurate marking: The exact position of a saw cut should be marked off on the work. For a cut at right angles to a straight edge, use a square. Fig. 2-A, and make a thin line with a scratch awl or sharp pencil. It is best to continue the line over the edge of the stock, detail B. Before marking, examine the end grain of the board. If possible, mark and cut from the side, as in detail C, so that the annual rings do not cross lower corners of the stock, detail D, which are apt to break off.



WORK HELD BY BENCH HOOK

SUPPORT SAW BLADE

USE THUMB KNUCKLE TO

HEEL OF SAW

BACKSTROKE FROM

START WITH SLOW



CHECK SAW WITH TRY SQUARE FOR RIGHT-ANGLE POSITION

LET INDEX FINGER POINT TOWARD SAW TIP



WHILE STARTING

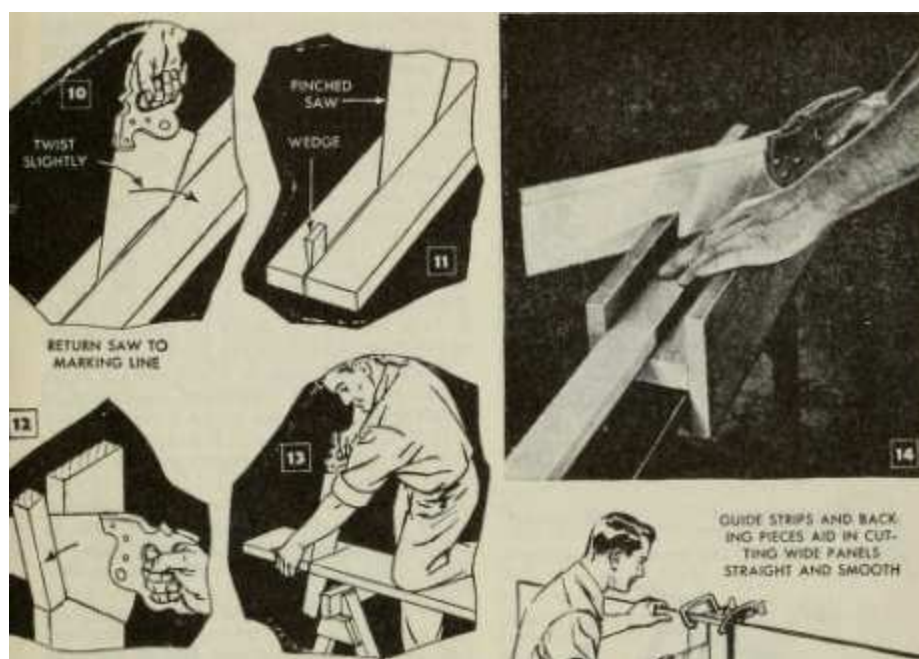
Guide lines for ripping can be made with a marking gauge, detail E, if the cut runs parallel to a straightedge. A ruler and block, detail C, allow marking with a pencil. If the edge of a board to be ripped is not straight, use a straight piece for marking. The saw kerf should always be made in the waste portion of the stock outside of the marked line, detail G, so that the cut piece will be of the exact length. Don't cut midway on the line as in H. If the edge of a rip-sawed board is to be planed smooth to the line, make allowance for it as in detail I.

Holding the work: Work to be sawed must be supported firmly. For crosscutting, you can lay the stock across two sawhorses of equal height, Figs. 3 and 4-A, or on boxes or old chairs. Hold the work with your hand or knee. When crosscutting, saw the work on the outside of one horse, close to it, rather than between horses. Rip-sawing long boards is done best between horses or other supports, detail B. Short pieces to be rip-sawed can be placed lengthwise on a horse. Work can be clamped in a vise for crosscutting, detail C, or you can use a bench hook as in D.

Sawing position and end grip: When sawing, bring your eye above the saw blade as in Fig. 5 to observe if the blade is being

held perpendicular to the work surface. If in doubt you can check with a try square, Fig. 6. Grasp the saw handle comfortably and easily with the index finger pointing toward the saw tip, Fig. 7, to help in guiding the blade.

Starting a cut: Whether crosscutting or ripping, start a cut by setting the heel of the blade alongside the mark. Fig. 8, and then pulling the saw back slowly, guiding the blade with the thumb of your left hand about an inch above the teeth as in Fig. 9. The palm of the hand rests on the work. The correct sawing angles, 45 deg. for crosscutting and 60 deg. for ripping, should be maintained throughout cutting. The starting stroke should be almost half the length of the blade, without any pressure. The weight of a saw is enough to start a kerf if the blade is sharp. Never start with a down stroke; you may apply too much pressure, splintering the wood at the edge or causing the saw to "jump." After the first backstroke, push the saw forward without increasing the pressure and continue with short strokes until the kerf is deep enough to retain the blade. Then move your hand about 6 in. from the saw and increase the length of the strokes gradually to full blade length, using very



DONT USE SAW TO PRY OFF WOOD BEFORE FINISHING THE CUT

HOLDING WASTE END TO

PREVENT SPLINTERING

AT FINISH OF CUT

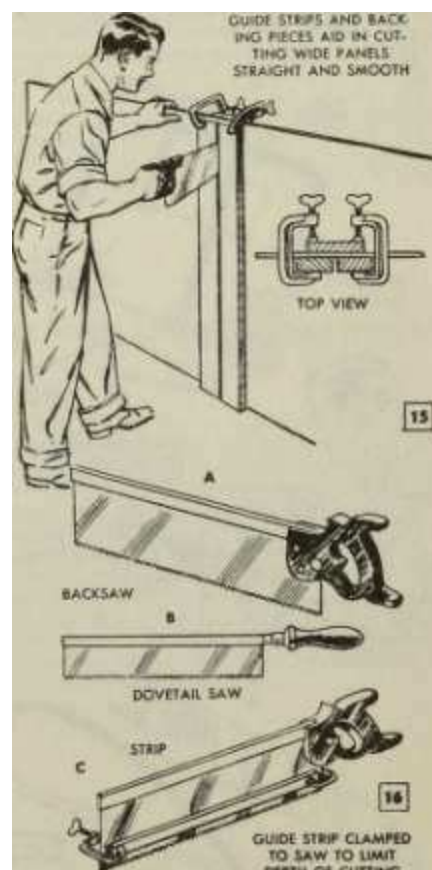
light pressure on the forward strokes only.

Sawing technique: Always start forward strokes slowly and increase the speed gradually. This minimizes the possibility of kinking if the blade should bind in the kerf. Kinks ruin blades for accurate cutting. When a saw drifts away from the marked line, apply a slight twist on the handle to bring it back, as in Fig. 10; don't twist the blade forcibly, as this may kink it. A saw that has a constant tendency to run off toward one side is not filed or set correctly, or the blade may be bent out of true. If the saw tends to cut at a slight angle, the blade is not being held perpendicular to the work surface. Bend the blade back to position gradually.

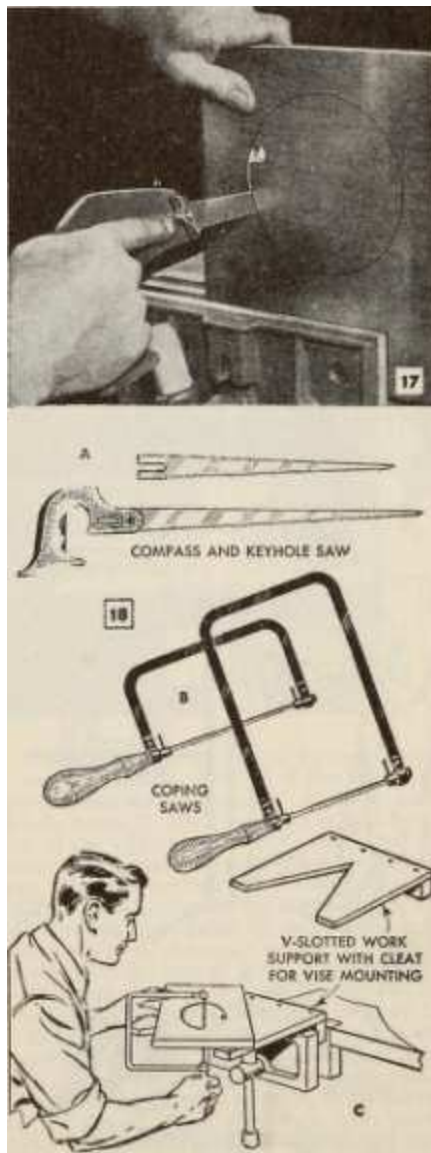
Vibration of the saw blade on upstrokes usually indicates that it is being held at too steep an angle with the work. When the stock pinches the blade,' sawing becomes difficult and kinking may result. When crosscutting, you may be able to open the kerf slightly by exerting pressure on the waste portion with your hand. Or you can use a wedge above the saw position. Fig. 11, which also is used to spread the kerf when rip sawing. Sometimes binding occurs when crosscutting between two supports and can be corrected by moving

GUIDE STRIPS AND BACKING PIECES AID IN CUT-

TING WIDE PANELS STRAIGHT AND SMOOTH



GUIDE STRIP CLAMPED TO SAW TO LIMIT DEPTH OF CUTTING



one of them closer to the sawing position.

Saw through knots slowly and carefully to avoid loosening them. When nearing the end of a cut, reduce the sawing speed and use short, delicate strokes while holding the free end of the stock with your left hand, Fig. 13. This prevents the end from breaking off and splintering a portion of the wood. Don't use a saw to pry off short waste ends, Fig. 12, or to break apart two pieces being ripped. In sawing old lumber, examine the stock and extract all nails in the path of sawing. If a broken-off nail is contacted, use a "nail" saw to cut through it—one having the same or greater width of set than the saw being used.

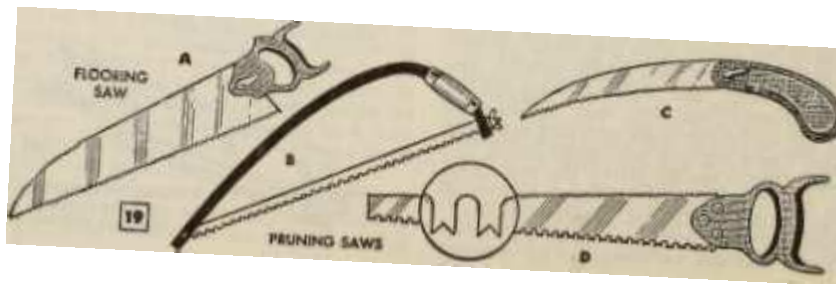
Sawing large panels: When sawing large panels of plywood, wallboard, insulation or plasterboard, you can make a straight cut with little fraying of the fibers on the back side by using two wooden guides and a backing piece, Fig. 15. Set the panel vertically. The guide pieces are spaced the width of the saw teeth and are clamped to the backing piece. You saw through the latter. For plasterboard, use an old saw or a plasterer's saw.

Accurate angle sawing: For cutting angles accurately, it's best to use a miter box, Fig. 14. To make a miter box of average size, use 2-in. stock for the bottom and 1-in. stock for the sides. The front should extend below the bottom to hook against the bench top. It also can

be clamped in a vise. If used often, a miter box should be clamped or screwed to the bench. Mark the angles to be cut in the sides with the aid of a combination square. A regular crosscut saw can be used in a miter box for most rough work, but for fine, accurate work use a hacksaw or dovetail saw. The slots in the miter box should be cut with the saw which is to be used in it. The work is first marked, then held firmly in the miter box against the back and bottom, positioned so the cut will be made along the line. Raise the handle end of the saw slightly and draw the saw back to start the kerf. Then saw horizontally until the cut is finished.

Saws for accurate work: For extreme accuracy in cutting moldings, picture fram-

FLOORING SAW



ing and other light stock, and for forming close-fitting joints, recesses, etc., use a hacksaw or a dovetail saw. Backsaws, Fig. 16-A, come in lengths from 10 to 16 in., and have 12 or 13 points per inch. Dovetail saws, detail B, are small versions of backsaws; come in 6 to 12 in. lengths with 15 to 17 points per inch. A miter saw is similar to a hacksaw but is 20 to 26 in. long, with 11 points per inch. On all three types, the blade is stiffened by a steel rib along the back. For accurate work the guide line on the stock should be cut with a knife; a pencil line is too thick. When sawing to a predetermined depth, clamp a guide strip on the blade, detail C.

Curved and internal cuts: For rough cutting of curves and internal cutouts, use a compass or keyhole saw. Figs. 17 and 18-A. A compass saw has a 10 to 16-in. blade, 8 to 10 points per inch and the teeth have a wide set. A keyhole saw is similar but smaller. The narrow blades of these saws permit turning in a small radius. Short strokes are best and the blades must not be bent. Twist the handle slightly to control cutting direction. For internal cuts, first bore a hole to admit the tip of the saw. In rough cutting, saw a little farther from the line to allow the wood to be dressed smoothly to the line with a file or spoke-shave. The work usually is held in a vise.

For finer and more intricate work in-

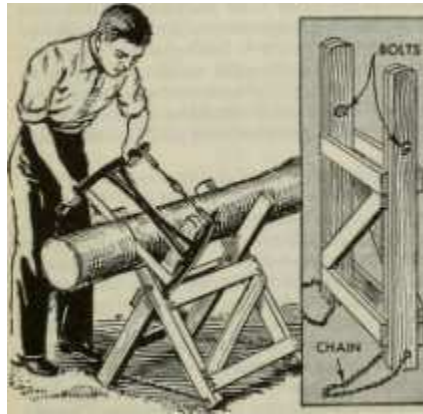
volving very small radii, use a coping saw, Fig. 18-B. The throat clearance of the coping-saw frame may vary from 6 to 12 in. The thin narrow blades can be inserted so that cutting is done on either the pushing or pulling stroke, the latter being less likely to kink or break the blade. A horizontal support having a V-shaped cutout, detail C, permits the work to be moved in any direction while sawing.

Special-purpose saws: Handsaws for cutting sheet metal have fine teeth milled straight across and tempered for filing action. A flooring saw, Fig. 19-A, has teeth on both edges. Such a saw eliminates boring holes to admit the blade when cutting into a flat surface that cannot be sawed from an exposed edge. Pruning saws, details B, C and D, may have straight or curved blades with teeth on one or both edges.

Saw care: Keep your saw sharp; it will be easier to use and will cut more accurately. Some home craftsmen prefer to do their own saw sharpening but the work is very exacting and the average homeowner will find it best to have sharpening done by an expert. Sap and other gummy substances that adhere to saw blades can be removed with a rag dipped in benzine. Prevent rust by keeping the blade coated with oil when not in use. * * *

SAWBUCK

This Folding Sawbuck Requires Very Little Storage Space



Every home owner likes to have a saw-buck for occasional use when cutting up scrap wood, tree limbs, etc., for kindling, but many owners forgo this convenience because a sawbuck of the regular type requires so much storage space. However, one that folds will solve the problem. It is made in the usual way except that the two parts of each X-member are pivoted together with a bolt, and a chain is substituted for the usual bottom brace. This permits the sawbuck to fold flat so that it takes practically no storage space.

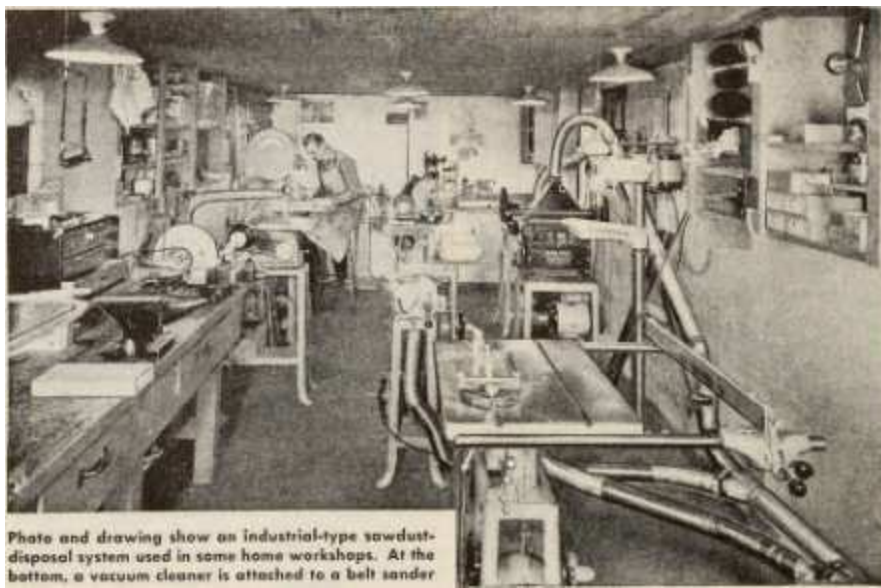
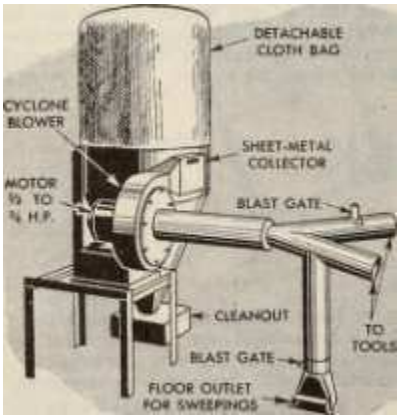


Photo and drawing show an industrial-type sawdust-disposal system used in some home workshops. At the bottom, a vacuum cleaner is attached to a belt sander

DETACHABLE CLOTH BAG



TO TOOLS

SAWDUST DISPOSAL SYSTEM

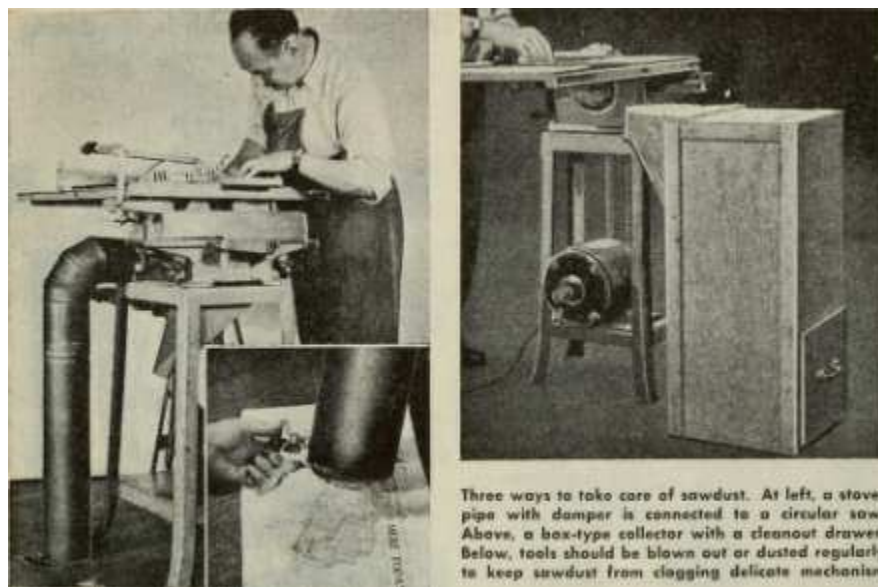


SAWDUST

A SPRINKLING of sawdust on the floor ■'■ is the trademark of the well-ordered woodworking shop, and the average craft-er is not too much concerned about the matter. What you do is kick it around for a week and then sweep it up. Meanwhile, it serves to

absorb moisture from the air and tends to lay finer dust particles. When you get to the stage where you do a lot of planer and shaper work — both heavy shaving makers—some thought might be given to installing a regular sawdust-disposal system with fan and cyclone separator, as shown in the photo above and the diagram at left.

Any blower type of dust collector you install must be pretty powerful—the idea that you can take a household vacuum cleaner and pull sawdust out of a buzz saw is strictly a pipe dream. Even a fair-sized outfit, say one driven with a Vs-hp. motor, has a static lift of no more than an inch. The sawdust must be actually thrown at the inlet. Once inside, the vacuum takes it scooting up to the separator. In this big chamber, the heavy chips fall to the bottom, while lighter dust remains in suspension. The air is filtered by one or more thicknesses of cloth or other substance and is then returned to the room. The exhaust can also be piped outdoors, although in view of the heat loss, this is not usually practical.



Three ways to take care of sawdust. At left, a stovepipe with damper is connected to a circular saw. Above, a box-type collector with a cleanout drawer. Below, tools should be blown out or dusted regularly to keep sawdust from clogging delicate mechanism

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What you can do with a household vacuum cleaner is attach it to the spout of a belt Sander, as shown in the photo at the bottom of the opposite page. An old Eureka cleaner is perfect for this and can be fitted almost as easily as a job made to order. Then, if you close the belt in as much as possible, this outfit will work because most of the dust is thrown right at the inlet. A similar fitting under the disk sander is also satisfactory. The fine abrasive dust produced by Sanders is, of course, the most annoying; if you do anything about sawdust disposal, apply it to sanders and grinders first.

Some kind of bag or box fitting behind the circular saw is standard equipment in many shops. Two ideas covering this are shown in the photos above, which are self-explanatory. The wooden cabinet with the cleanout box is much neater, but the stovepipe with damper will do the trick. A similar fitting is made for the jointer or, if you use a combination setup, one box can serve both machines. Cabinet-model saws usually have their own dust

chamber in the base and require no special fitting. Tools should be blown out or thoroughly dusted at regular intervals. This is hardly dust disposal, since the stuff goes flying all over the shop, but it is essential in keeping your machines in good working order. The damage



that can be done by shop dirt in a power tool is insidious but certain.

Any crafter will give you this final pointer about sawdust: Don't wear pants with cuffs. If you do, you will forever be tracking dust through the house and, worst of all, spreading a beautiful cascade when you prop your feet up on the davenport. A second common-sense idea is to paint the floor and walls of the shop so that it sweeps or dusts clean with a minimum of effort.

SAWHORSE WORK HOLDER

Work Held at Angle on Sawhorse With Hinged Blocks

Dog Holds Log Firmly in Sawbuck While Cutting Stove Wood

2X4 BLOCK.





To hold boards at a convenient sawing angle on a sawhorse, a carpenter hinged wood blocks at each end as indicated. The blocks are provided with dowel pegs for supporting the work, and holes bored into the legs receive the dowels when the blocks are folded down out of the way.

Sawhorse 'Clothespin' Holds Work on Edge for Planing

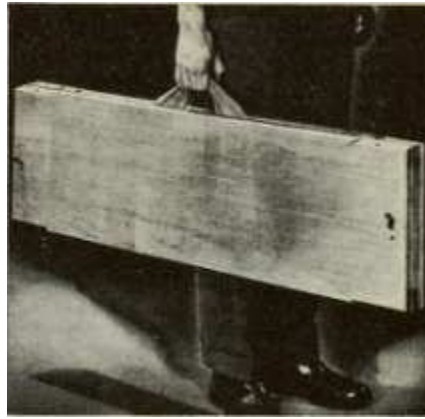
A support resembling a clothespin for holding boards on edge for planing on a sawhorse, is made easily from two 1 by 6-in. pieces spaced with a block so that they straddle the rail of the horse. For most work the support will stay in place without being fastened, but may be attached rigidly by threading a thumbscrew through one side to engage the sawhorse.

Anyone who has been annoyed when sawing stove wood by having the logs roll and twist, can avoid the trouble by using a dog attached to one end of the sawbuck. The dog is shaped from flat iron, and it should work freely on the bolt that pivots to the frame.

1"x6"x14" Pieces



SAWHORSE



Demountable Sawhorse Is Ideal

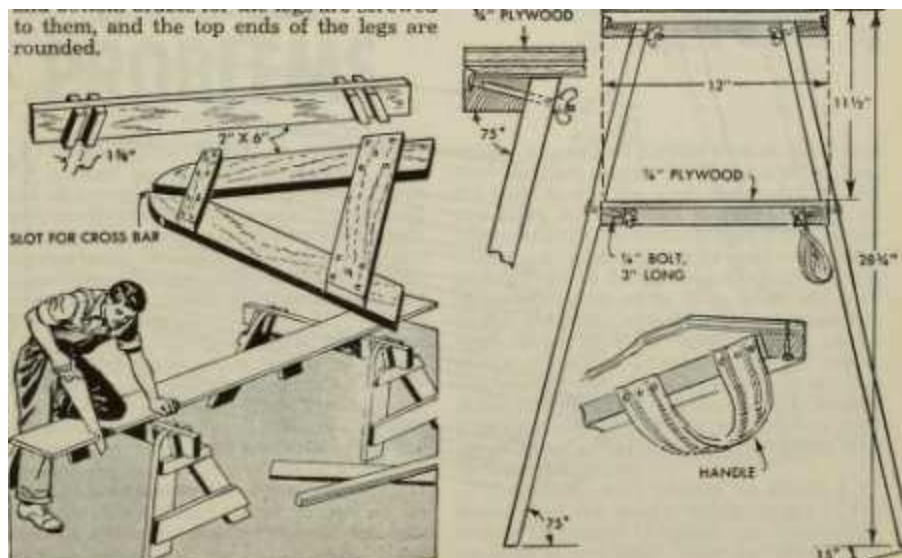
In Basement Workshop

If you are cramped for space in your basement, these demountable sawhorses will come in handy because they require little storage space when taken apart. Cleats are nailed to the cross bar, forming a slot that fits between the legs. The top and bottom braces for the legs are screwed to them, and the top ends of the legs are rounded.

IF YOU HAVE wanted a sturdy, work-^ bench-type sawhorse — one that can be set up quickly to make minor home repairs or for general tinkering — this one should fill your needs perfectly. Designed for packing the legs in a pocket formed by the top and shelf, the sawhorse is carried like a suitcase and takes no more space than an ironing board. This makes it easy to store in a closet, utility room or under a bed. It's made to order for the man who lives in an apartment, or a small home without a basement where space is at a premium.

The drawings give a clear idea of how the

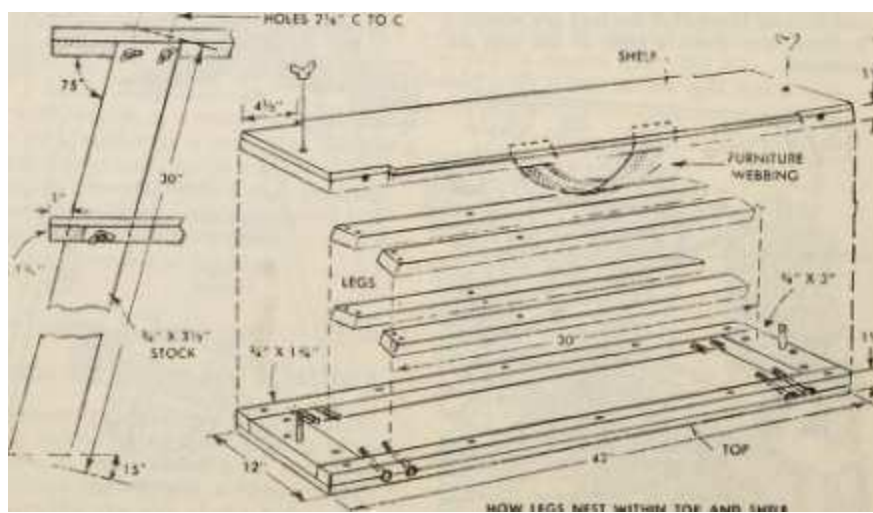
Vt" PLYWOOD



parts go together. If you want the horse to withstand hard usage, make the parts of hardwood such as birch. The recesses for storing the legs are formed by screwing a fiat framework to the underside of both the top and the shelf. Note that in the case of the top frame, the inside edges of the side strips are beveled 15 deg., while 15-deg. notches are made at the outside corners of the shelf. The legs are made in pairs, right and left-hand. Compound cuts at both ends of each leg make the legs slant equally in two directions. Carriage bolts which lock the legs to the top are a wedge fit and are left permanently in place. Those holding the shelf are a loose fit, two of them being used to clamp the top and shelf together when packing the unit for storage. Note that the bolt holes in the edge of the top are counterbored to seat the bolt heads properly, while the side strips of the shelf frame are beveled 15 deg. to provide a fiat surface for washers and wing nuts. A strip of upholstery webbing forms the handle. Finish the sawhorse with a coat of shellac and follow with varnish or lacquer.

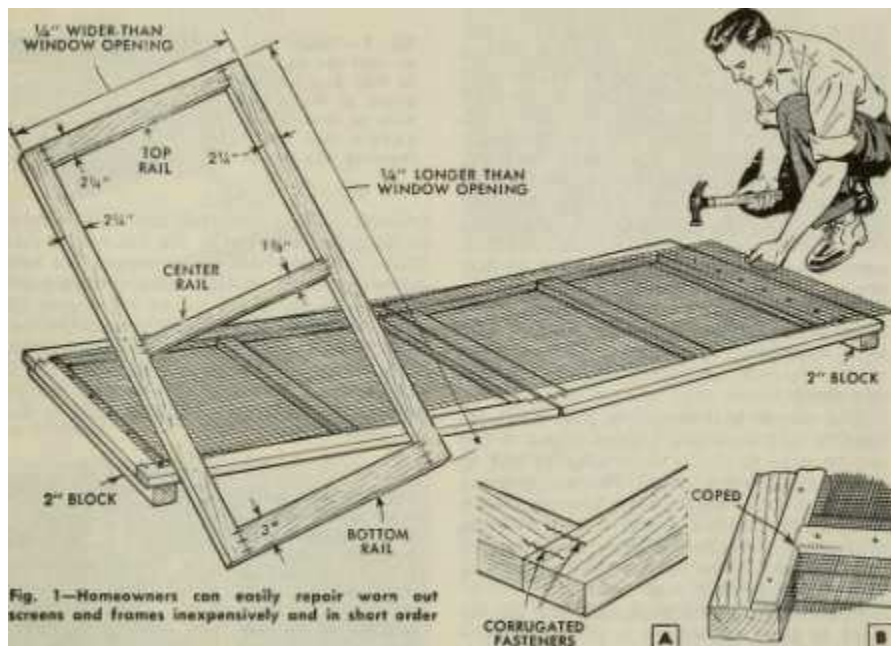


■HOLES 2'.8" C TO C



HOW LEGS NEST WITHIN TOP AND SHELF

1/4" WIDER THAN WINDOW OPENING



2" BLOCK

Fig. 1—Homeowners can easily repair worn out screens and frames inexpensively and in short order

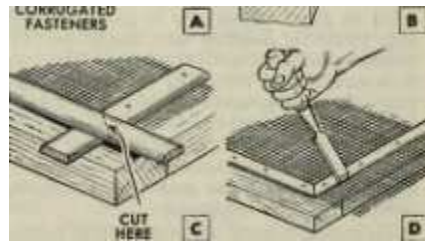
SCREEN PROBLEMS

WINDOW SCREENS, as most homeowners are only too well aware, present an annual problem. Some screens will need re-covering, some a new frame, and others will be scarred with small unsightly tears or holes. With the following hints and suggestions, however, the work is not so difficult for any homeowner to do himself and at very little cost.

Clear white pine, 1/2 in. thick, is the best wood to use when a new frame is needed. It is stocked by most lumberyards. As for tools, a simple wooden miter box, a hammer and a

chisel or sharp knife are all that is necessary. All pieces are cut so that the assembled frame will be about $\frac{1}{8}$ in. larger over all than the window. This makes it possible for the bottom to be planed at an angle to match the slant of the sill and also permits the rest of the frame to be fitted snugly. See Fig. 1 for general diagram.

CORRUGATED FASTENERS



HERE L~J

Top, center and bottom rails of the frame are the same length. By using a miter box, it's easy to cut the ends squarely and, by providing a stop block, each piece can be cut to exactly the same length. If a long bar clamp is available, it can be used to hold the pieces in place for nailing. Corrugated fasteners or wiggle nails, $\frac{1}{8}$ in. wide, are used to nail the joints, detail A. These are driven flush about $\frac{1}{2}$ in. in from the edge and a nailset is used to drive them slightly below the surface to allow puttying over. Use three fasteners on each side of the bottom joints and two at all other joints. It's a good idea to coat all joints with paste white lead before assembling.

The screen wire should be about 1 in. wider than the inside measurement of the frame. To stretch it tautly, two frames are covered at one time. They are placed end to end and blocked up at the outer ends.

The wire is tacked across the end of one frame and then pulled firmly and tacked across the end of the other frame. Use common cai'pet tacks or screen staples and space them about 3 in. apart. With this done, the blocks are removed and the tacking is completed with the frames flat on the floor, after which the frames are cut apart.

The edges of the screen wire are covered with stock screen molding. The molding is permitted to overlap at the corners and then a saw is run through both strips at a 45-deg. angle, as in detail C, resulting in a perfectly fitting joint. At the center rail, the molding is coped, or undercut, as in detail B. The job is completed by trimming off the excess wire at the ends, as in detail D, with the heel of a sharp chisel.

The simple tool shown in Fig. 2 can be used to fold over the ragged edges of the screen wire to make them smooth and to avoid injuring the hands. The tool is made from a piece of sheet metal bent as shown and provided with a handle. In use, the edge of the wire is rolled slightly, then started into the tool, after which pulling the tool along folds the wire over tightly.

One of the newest materials that can be used to good advantage is plastic screening, which is flexible and easily cut with ordinary scissors to fit the frame. The color is impregnated into this rustproof stain-proof screening, and it needs no protective painting. Ideal for exterior use, this screening may be left on windows the year 'round, if desired. Plastic is easily washed with a damp cloth, thus the ease of maintenance reduces upkeep expenses.

To install plastic screening, first remove molding and the old screening and cut the new screening to fit the frame. Allow enough material at the cut edges for a fold-over hem. Starting at the top, tack the screening to the frame, placing tacks an inch and a half apart, then next tack the



Fig. 2 — Simple tool at right can be used to fold over ragged edge* of the screen wire to make them smooth and avoid injuring the hands

bottom, as this prevents the screen from pulling. See Fig. 4. On the cut edges, fold under the hem for reinforcement. No hem is needed for the salvage sides of the screen, unless it is necessary to cut for proper fit. Lay the screening evenly, with a firm but not taut pull, before tacking the bottom and sides to assure a perfect fit. Tack the molding back on over the hem to give added support and a finished appearance to the

Fig. 3—To fit meld-ings, apply screen wire, tacking en one molding strip and letting it project 1V!z in. at each end. Let adjoining strip overlap end of first strip. Next slip tin under strips at joint and cut through both pieces of the molding

frame, as demonstrated in Fig. 5, and it's ready to install.

Regardless what type of screen you may have, window-screen latches can be a problem, especially when within the prying grasp of children who invariably will unhook the latch and push the screen out. To avoid this, drive a screw in the parting stop and hook in the screen. Then wire the hook to the head of the screw, as shown in Fig. 13.

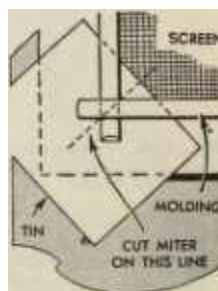
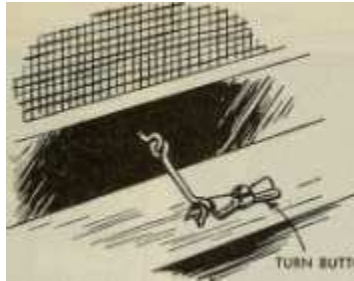
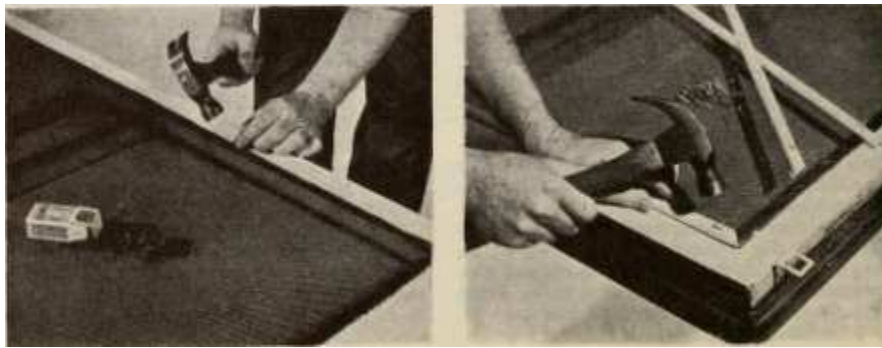


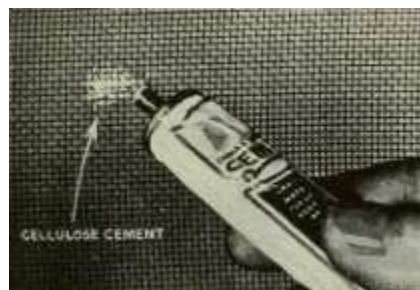
Fig. 4— After the sides are tacked in place, fold under the cut edges to make about a half-inch hem

Fig. 5—Tack molding on over the hem to give added support and a finished appearance to the frame



TURN BUTTON Fig. 6—Secure screen hooks by using turn buttons

Window-screen hooks also can't be opened if they are locked in the screw eyes with turn buttons. The latter, of course, should be fastened tightly as illustrated in Fig. 6. Another and even simpler method of keeping hooks locked is by turning the



CELLULOSE CEMENT

Fig. 7—Repair small holes with cellulose cement

screw eye up over the shank of the hook with a pair of pliers.

To repair a hole in wire screen so that it will not be noticeable, no thread or string is needed. First trim the hole neatly, as nearly rectangular as possible. Then cut a piece of screen wire about 1 in. larger than

8 — Staple plastic screens

better results

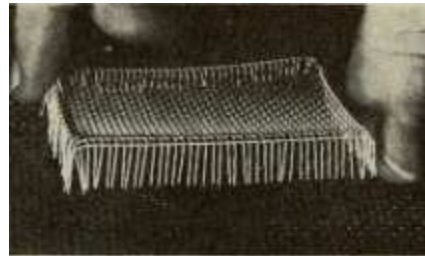


Fig. 9 — Patch method simplifies screen repairing

the hole each way. Unravel the edges for about three or four strands back. With a straightedge turn the projecting ends up to a sharp right angle. Insert them carefully through the screen, turn them down and tap them flat, using a hammer and a back support to prevent bending the screen out of shape as in Fig. 9.

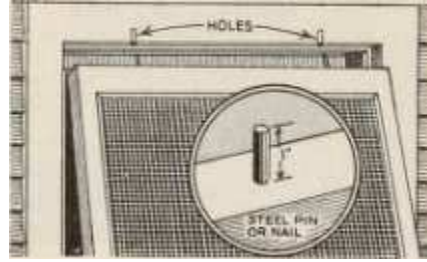
Better results are obtained when applying plastic screen to a frame with a stapler, demonstrated in Fig. 8. The screen will have less tendency to pull or tear because a staple covers a greater holding area than a tack. Also, one hand is left free to keep the plastic screen stretched tautly as it is being stapled.

For temporary patch jobs, cellulose tape can be used to mend torn screens. Cover both sides of the hole with the tape and then press the adhesive surfaces of the tape together. As the tape is transparent, it will not be too noticeable.

Bronze and copper screen wire in a roll-type window screen sometimes frays and breaks at the outer edges as a result of wear in the channel guides. It's a simple matter to repair these spots with small patches of solder. See Fig. 11. If the wire is torn, a bead of solder is run the length of the break after first brightening the spot with fine sandpaper. Small holes in the mesh can be repaired, in most cases, merely by cutting off a small piece of wire solder, placing it over the hole and then hammering it flat to mat it in the mesh. This is usually sufficient for a good bond, although a hot iron can be touched to the spot. If the thickness of the solder at the repaired places causes binding in the guides, file the solder patches flush with the surface of the screen wire.

If you're going to install half-screens, this suggestion may help. Small hooks serve as stops at the base; the screen rests against the sash at the top and turn buttons on the sides hold it in place as shown in Fig. 12.

Also, a good way to hold window screens in place is to drive two nails or steel pins in the top of the screen frame about 6 in. from each end, shown in Fig. 10. Then mark the positions of these pins on the window



ROLL-TYPE SCREEN

Fig. 10—Two steel pins can hold screens in place

frame and drill two holes slightly larger than the pins at these points. To install the screen, all you need to do is slip the top of it in place and lock the bottom part of the frame with an ordinary hook and screw eye.

During heavy rainstorms, tight-fitting screens often trap water between them and under the sill and moisture runs down the wall inside the house. The best remedy for this is not to loosen the screen, but rather to saw several shallow slots in the lower rail of the screen frame to provide for escape of the trapped water.

On the whole, window screens can be kept clean with only an occasional dusting if given a coat of liquid wax before they are put up. All that is needed is to apply wax with a pad of cheesecloth or toweling tacked to a wooden block. Another good protective finish for window screens consists of a mixture of varnish, 2 parts, linseed oil, 1 part, and turpentine, 1 part, which can be applied with a piece of carpet tacked to a wood block.

Screens are rustproofed before storing for winter by coating lightly with linseed oil. Apply oil in the same method cited in the preceding paragraph.

When it's time to take screens out of storage, fitting moldings isn't as difficult a task as you might think. This suggestion may help save you hours of painstaking work. Using Fig. 3 for a guide, after applying the screen wire, tack on one molding strip, allowing it to project $1\frac{1}{2}$ in. at each end. Then tack on the adjoining strip so that it overlaps the end of the first strip, as indicated. Drive the nails only about halfway in near the end and then slip a piece of tin or thin wood under the strips at the joint, making the miter cut through both pieces of molding. This will give a neat joint to the screen when the molding is tacked down.

Roman numerals formed with small staples on screens and their respective window openings, are a good way to identify them come next spring. Neither weather nor subsequent paintings will obliterate the numerals.



BREAK IN SCREEN



-TEAR IN SCREEN



' SOLDER



GLOBULES OF SOLDER

Fig. 11—Roll-type screens repaired with solder



are no problem to install

Fia. 13— To avoid window-screen being pushed out, drive screw in parting stop and hook in the screen







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